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BEFORE THE

SUBCOMMITTEE ON
WATER RESOURCES, TRANSPORTATION, AND
INFRASTRUCTURE

OF THE

COMMITTEE ON
ENVIRONMENT AND PUBLIC WORKS
UNITED STATES SENATE

ONE HUNDREDTH CONGRESS

SECOND SESSION

ON

REGIONAL TRANSIT INFRASTRUCTURE AND THE POTENTIAL OF MAGNETIC LEVITATION TECHNOLOGY FOR INTERCITY TRANSPORTATION

PART 3

JANUARY 21, 1988

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REGIONAL TRANSIT INFRASTRUCTURE AND THE POTENTIAL OF MAGNETIC LEVITATION TECHNOLOGY FOR INTERCITY TRANSPORTATION

THURSDAY, JANUARY 21, 1988

U.S. SENATE,
COMMITTEE ON ENVIRONMENT AND PUBLIC WORKS,
SUBCOMMITTEE ON WATER RESOURCES, TRANSPORTATION,
AND INFRASTRUCTURE,
New York, NY.

The subcommittee met at 9:30 a.m., at the Court of International Trade, 1 Federal Plaza, New York, N.Y. Hon. Daniel Patrick Moynihan (chairman of the subcommittee) presiding.

Present: Senator Moynihan.

OPENING STATEMENT OF HON. DANIEL PATRICK MOYNIHAN, U.S. SENATOR FROM THE STATE OF NEW YORK

Senator MOYNIHAN. Good morning. I would like to welcome the invited witnesses and guests to this hearing of the Subcommittee on Water Resources, Transportation, and Infrastructure. This is the fifth in a series of hearings on the condition of the Nation's infrastructure.

Our objective in these hearings has been to enhance our understanding of the condition of the national infrastructure, to identify and explain the nature of the problems that confront these systems, and to generate creative but realistic approaches to assuring that these basic underpinnings of the Nation's well-being and economic growth are intact and meeting our evolving needs.

In these hearings we have adopted a broad definition of the concept of infrastructure. This definition includes the traditional public works categories such as highways, bridges, and other facilities providing transportation, water resources, and waste management. But we have been mindful that the public is most concerned about essential services rather than the mechanisms by which they are delivered. They are interested in getting to work on time, getting products to market, having an adequate supply of clean water, and in the safe elimination of wastes.

From this perspective we have focused the subcommittee's inquiry on several major questions:

What are the appropriate roles of the various levels of government and the private sector in providing infrastructure services?

What role do infrastructure services play in economic growth and international competitiveness?

How can we best finance the needed rehabilitation, maintenance, and development of our infrastructure?

Do we have a properly trained work force adequate to the task of planning, designing, building, maintaining, and managing our infrastructure services delivery?

Would changes in Federal budget procedures, such as the adoption of a more thoroughgoing capital budgeting process, be useful?

Are we conducting sufficient research and development related to infrastructure?

Are we adequately considering the impact of technological innovation on these systems?

The major construction projects that the United States Government has been involved with in the past generation are coming to a close. In the Interstate and Defense Highway Program we have the world's largest public works program in the history of the world; it began in 1966, and the Surface Transportation Act of 1987, which we passed with some difficulty this spring, in effect brings that program to a close. It ends the Highway Trust because after 30 or 35 years, the highway system will have been built. There will be some little bits of disputed sections, but no more. And similarly, the first bill that we passed, the Clean Water Act, brings the clean water construction program to an end. We are, in fact, bringing down two very large programs, and we have nothing to succeed them; not that you necessarily need something in that sense, but indeed the needs of infrastructure and public works are quite real. It has been quite well established in our testimony that we have been disinvesting in public works over the years. The proportion of GNP going to infrastructure has been declining, and I think the argument—at least at the level of economic analysis—is certainly defensible, that we have been disinvesting. It is clearly felt that we will be doing so if we just end what we are now doing and do not begin anything else.

Two things bring our attention here today. First is the whole question of urban mass transit, and we're going to hear from very distinguished public officials who can particularly testify to the process of disinvestment which took the New York City Metropolitan Area Public Transit System into near collapse until a decade ago. It has been turned around due to some remarkable public men and elected officials as well. It is not yet complete; there is much yet to be done.

We would also like to talk about a question of a new system of long-range transportation in the country, which has acquired the name "mag-lev" for magnetic levitation. We here are really on the edge of making a big decision, which is to say that the United States has done the basic science and most of the technology—to the degree that there now is technology—to establish this new form of transportation. It would be the first new form of transportation since the airplane first flew in 1903, or since the first successful manned flight at Kitty Hawk. The question is whether it will first appear in the United States or whether it will be developed by Japanese entrepreneurs and their government, or alternatively, by West Germany. And in England, too. In the Federal Re-

public of Germany, in the United Kingdom, in Japan, this technology is at the level of experiment. It's on the verge of becoming—well, it certainly is at the level of a demonstration project. It has not happened here. If it doesn't, the question is whether we will end up seeing our technology first put in place overseas. Not that it's our technology, but it's certainly the kind of work that ought to attract us.

I'd like to put my statement into the record on this subject, and also put into the record an article from U.S. News and World Report entitled, "Wanted: A Dozen New Airports." Nothing is more clear, I would have thought, than that the airspace over the major American cities is just about crowded to the point that you can't get any more aircraft into it. The heavy corridors, like Boston-New York-Washington, are particularly so. The capacity to build new airports is running into the same difficulties as building new highways encounters eventually. The last new major airport in this country was opened in 1974, the Dallas-Fort Worth Airport. The lead time is getting to be 20 to 30 years; the airspace isn't there. On the other hand, we have the possibility of using the Interstate system right-of-way with this new technology to move people at speeds somewhere between 300 and 400 miles per hour.

Something ought to be established, which is, that you cannot move people by air from New York to Washington at such speeds. It's technically possible, but the capacity of the system is not. And the possibility of generally moving passengers at about 350 miles an hour in various directions in this country is a very real one, and not to explore it seems a very great mistake.

We introduced legislation late last year called the FAST Act, which stands for Federal Advanced Superconducting Transportation Act, or FAST Act. It suggested that $100 million be given to NASA to begin developing this mag-lev technology.

We can always look back to President Kennedy's speech in 1961—I remember it at the time—in which he proposed that we send a man to the moon and return him in that decade. He said that while we cannot guarantee that we shall one day be first, we can guarantee that any failure to make this effort will make us last. I also recall in the same speech where he said we would go to the moon, he also said we would go to Vietnam, so you'd better be careful of what you say in speeches.

[Senator Moynihan's statement and the article referred to follow:]

OPENING STATEMENT OF HON. DANIEL PATRICK MOYNIHAN, U.S. SENATOR FROM THE STATE OF NEW YORK

Good morning. I would like to welcome the invited witnesses and guests to this hearing of the Subcommittee on Water Resources, Transportation and Infrastructure. This is the fifth in a series of hearings on the condition of the nation's infrastructure.

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waste management. But we have been mindful that the public is most concerned about essential services than the mechanisms by which they are delivered. They are interested in getting to work on time, getting products to market, having an adequate supply of clean water, and in the safe elimination of wastes.

From this perspective we have focused the Subcommittee's inquiry on several major questions:

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Would changes in Federal budget procedures, such as the adoption of a more thoroughgoing capital budgeting process, be useful?

Are we conducting sufficient research and development related to infrastructure.

Are we adequately considering the impact of technological innovation on these systems?

The focus of today's hearing, for which we have two panels of distinguished witnesses, is the transportation infrastructure. Specifically, how can people and products move most efficiently both within and between urban areas.

New York City's need for transportation services and the potential for developing exciting approaches for addressing its needs make it an appropriate location for this hearing. One third of all the nation's mass transit users live and work in the New York metropolitan area. No area is as dependent for its economic well being upon an efficiently operating mass transit system as are we.

I was recently able to assist the Port Authority is a small way by sponsoring legislation which will facilitate efforts to develop commuter ferry service between New Jersey and lower Manhattan. I look forward to hearing today of the plans for that service and for both the Port Authority's and MTA's counsel on how the federal government can constructively contribute to the success of their constant efforts to improve their services. I welcome Bob Kiley and Mort Downey of the Metropolitan Transportation Authority, Louis Gambaccini of the Port Authority and George Warrington of Jersey Transit to the hearing.

I am also pleased to hear the testimony of Mr. Carmen Arcuri who is responsible for management of the Utica Transit Authority. I understand he is also an officer of the New York Public Transit Managers Association whose meeting he is missing in order to be here this morning. We very much look forward to his testimony.

In addition, our hearing today has a second focus—transportation for intercity travel. At the same that we explore ways to improve the daily commute of our nation's workers, we must be mindful of the next revolution in transportation technology—a space age system. It is magnetic levitation. It will soon be upon us and we must be ready.

We have not experienced a quantum leap in passenger transportation technology since 1903 when the Wright Brothers flew at Kitty Hawk. Our ground transportation technologies are even older. The railroad is an early 19th century development; the automobile a late 19th century adaption.

That is why on October 16, 1987, I introduced the first legislation that provides a blueprint for a federal effort to assist in the development and implementation of a U.S. magnetic levitation system. My bill, S. 1794, the Federal Advanced Superconducting Transportation Act, or the FAST Act, would meld the basic technology of magnetic levitation which was developed in the 1960s and 70s with recent advances in superconductivity to give the United States a leadership position in maglev travel. Since magnetic levitation and superconductivity have been largely developed by American scientists—we cannot permit other countries to reap the commercial benefit.

Indeed the Japanese and the Germans have launched large maglev development programs. The Germans lead in a conventional magnet system and the Japanese in the superconducting version. They are aggressively seeking commercial opportunities. The United States, meanwhile, stopped its development efforts in 1975.

It is now time that we get back in the transportation race. It is a challenge that is in many ways as important as the space race that captivated the nation in the 1960s. In that era we had fallen behind the Soviets. In this era we have fallen behind the Germans and Japanese. The exhortation of President Kennedy to the nation in 1961 for a space race is just as true for the maglev race: ". . . while we

cannot guarantee that we shall one day be first, we can guarantee that any failure to make this effort will make us last."

My bill once again calls upon NASA to lead the country in the development of this technology. It would provide $100 million in research and development funds to be administered by NASA so that we can catch up to the Japanese and Germans and have a commercial technology within two years.

Fortunately, we are not that far behind yet. We are in a favorable position to "leapfrog" what the Japanese and Germans have achieved and to take the lead fairly quickly if we seize the opportunity. The benefits of maglev are astounding. A maglev system at speeds of over 300 miles per hour could bring people from New York to Boston or Washington in a fraction of an hour. The safety hazards and congestion associated with automobile and air travel could be relieved. Maglev is energy efficient and quiet.

S. 1794 also establishes a new office within the Department of Transportation to draft standards for the national development of maglev and to work with state and local entities to provide the necessary ingredients for actual construction of such systems in the 1990s.

We look forward to hearing testimony from two distinguished scientists today. They will give us a better understanding of the potential of maglev and its proper place in the future of intercity transportation.

First, we have Dr. Henry Kolm. A genuine pioneer of magnetic levitation technology in the 1960s, Dr. Kolm is the designer of the only existing U.S. maglev technology. A company with which he is associated is active in an effort to establish a maglev system in the Florida corridor.

Our second scientist is Dr. Francis C. Moon. Dr. Moon is the Director of the School of Mechanical and Aerospace Engineering at Cornell University. He has been a long-time advocate of maglev development in the United States.

Lest anyone doubt that maglev transportation will soon be an integral component of intercity travel, we had planned to hear from Mr. Jack Thomason of the City of Las Vegas on the progress made by Nevada and California on the introduction of a maglev system in the Las Vegas-Southern California corridor. As is often the case, state and local governments are quick to embrace new ideas to solve regional issues. Unfortunately, due to the effects of weather on the air transport system he will not be able to join us today. I am pleased to place his prepared testimony in the record.

[From U.S. News & World Report, Jan. 25, 1988]

WANTED: A DOZEN NEW AIRPORTS

AIR-TRAVEL DELAYS CAN ONLY WORSEN IF THE CRUNCH ON THE GROUND DOESN'T IMPROVE

In 1975, movers and shakers in the Mile-High City got together and finally faced the inevitable: They needed a new airport, and desperately. Old Stapleton International was just spilling over with planes, passengers and problems. Something had to be done. Today, however, despite some $5 million in planning and related start-up costs, not a scoop of earth has been turned, and it's not certain that a new airport will ever be built in the Denver area. Suburban residents must vote soon to allow the annexation of land for the project, and if they give the O.K., a new airport just might open by 1995, fully 20 years after the decision was made to proceed. And that, believe it or not, is the good news.

FROM BAD TO WORSE

The bad news is that Denver—despite the fact that America's aviation system is bursting at the seams—is the only major metropolitan area moving forward with plans for a new airport. The last new big-city airport built from scratch was Dallas-Fort Worth, which opened in 1974, when U.S. airlines carried just 207 million passengers. After deregulation of the airline industry in 1978, traffic skyrocketed, and last year the airlines boarded some 450 million passengers. That total is expected to climb to about 750 million by the year 2001—and still new airports remain little more than a gleam in the eyes of industry experts and increasingly frantic government regulators. "The lack of adequate airport capacity," says J. Donald Reilly of the Airport Operators Council International, "will be the major problem facing U.S. aviation over the next 15 years."

How bad will it be? Already, some 16 major U.S. airports are seriously congested and plagued by enormous delays. By the year 2000, 42 others are projected to be in

similarly dismal shape—meaning that more than three quarters of U.S. passengers will be affected unless bigtime remedies are forthcoming. No doubt, a variety of technological innovations—equipment updates, terminal expansions and rejiggered air-space plans—will help. So will more air-traffic controllers. But there's little question that airports comprise a significant chunk of the long-term solution. Industry groups assert that anywhere from 10 to 16 major new airports will be needed nationwide over the next 10 to 15 years. And while Federal Aviation Administration officials won't set a definitive timetable, they do say that new airports look like the last and best long-term solution for at least eight markets—New York, Los Angeles, Chicago, San Francisco, Detroit, St. Louis, Phoenix and Denver. "There is not a lot of time left for talk," says James Murphy of the Air Transport Association of America, which represents airlines. "It's time for some hard, hard political decisions."

But politics is at the very root of the problem. First, there's the question of land. Passengers want a close-in airport for the sake of convenience. But the latest industry thinking is that as much as 30,000 acres may be needed for a large-scale jetport. Try finding that much land near a big city—and then building on it without a fight from zoning authorities, environmental activists and especially neighbors objecting to high noise levels.

Time is a problem, too. Building an airport can take 10 to 20 years, requiring the kind of tenacity, patience and continuity that are rare in local government. "Everybody may want a new airport," says FAA Administrator Allan McArtor. "But they want it on the other side of the city." Consequently, nothing gets built.

Money, not surprisingly, is another formidable problem. A big new airport is going to cost about $3 billion. And it has to come from a lot of different people's pockets. Some federal money is available to help, but it has been hard to get at because of bureaucratic snits in Washington, though the worst of the logjam now seems to have been broken. And in any event it isn't likely to pay more than 20 percent of the bill. Strapped cities and states will have to ante up. And much of the money must come from airlines in the form of increased landing fees and airport-lease payments, which would be used to retire bonds issued by the local government—often a city, county or hybrid board—responsible for the airport. That sounds easy, but the fact is that airlines may well balk, because new airports aren't always in their interest, especially when one might lead to increased competition. And if airlines are going to carry that much of the fiscal freight for a new airport, they may want more control than local governments are willing to give them.

THE HOT-WATER FACTOR

Federal officials believe the political radioactivity of these issues may be too much for mayors and governors to deal with. While the community at large may have a vague understanding of the need for a new airport and the economic benefits that's no match, they say, for the emotional fervor of smaller groups that would be most directly affected. "Building or expanding an airport," says Robert Warner of the National Association of State Aviation Officials, "gets local officials in hot water."

Even though airports are linchpins in a national system of interstate commerce, building them is strictly a local matter. The federal government can help, but it has no jurisdiction. Many believe that's problem. "We may need to modify our working philosophy," says Quentin Taylor, deputy associate FAA administrator for airports, "so as not to become totally dependent on local initiatives for airport development." But the prospect of handing over airportsiting authority to the feds augurs a political battle few have the stomach for.

What to do, then? Industry leaders believe the FAA must come up with a long-term master plan for the nation's aviation system—and then vigorously push localities to build the new airports needed to make the plan work. Research is already under way, and a report is due next spring. In addition, McArtor is expected to announce this week a new plan to deal with airport-capacity problems. All of which is heartening, but, many believe, too little, too late. "The industry," says FAA counsel E. Tazewell Ellett, "generally thinks we have moved far too slowly on these issues."

Now, though, both FAA Administrator McArtor and Ronald Reagan's new Transportation Secretary, James Burnley, say the issue of "airport capacity"—to use the industry jargon—is at the top of their agendas. And ideas once considered simply outlandish are being given serious scrutiny. One such proposal flows from today's "hub and spoke" route structure, in whcih flights radiate from a major airport like spokes from the hub of a wheel. Since so much of a hub airport's traffic is simply people changing planes. why not build a hub or two in unpopulated rural areas, where opposition would be limited? Airlines might resist, but a superhub in a remote area, says Burnley, "may be a better alternative than not expanding capac-

ity sufficiently." Other ideas include swapping new, farther-out airports for existing military fields closer to downtowns. One partial solution would be to make better use of underutilized airports such as Milwaukee and Columbus, Ohio, by encouraging airlines (through federal funding priority, for instance) to put minihubs there—extending a trend already begun in cities like Nashville.

Still, these are just partial solutions. And none changes the fact that new airports will be needed—and much more is at stake than the inconvenience of air travelers. "Over the next decade," says Burnley, "the consequences would [include] fewer jobs and a lost edge in international trade. * * * There's a whole panoply of unhappy outcomes if we stifle the growth of our aviation system."

Senator MOYNIHAN. I regret to report that one of our witnesses was to have been Mr. Jack Thomason of Las Vegas, who was going to testify on the progress being made by Nevada and California in introducing a mag-lev system in the Los Angeles-Southern California corridor, and it is to be noted that he is not here because the airport is fogged in. If we had that system that he would like to introduce, he might arrive—not by rail, but on rail. But in any event, let's get on with this.

We are very pleased this morning to have the Honorable Robert Kiley, Chairman, Metropolitan Transportation Authority, and his able associate, Mortimer Downey, who is Executive Director; George Warrington, Deputy Executive Director, New Jersey Transit; Mr. Louis Gambaccini, Assistant Executive Director, Port Authority of New York; and finally, Mr. Carmen Arcuri, General Manager, Utica Transit Authority.

Gentlemen, what we ask of you is to support the record which we are compiling for legislation which we are now drafting. If we could hear from you your general thoughts on where you are in the area of regional transit, what your capital plans and resources are, and what you hope to see from the Federal Government.

I'm just going to do what we routinely do, follow the list of witnesses.

Mr. Kiley, we welcome you, sir, as we always do, and we welcome Mr. Downey. Perhaps you will proceed as you think best. If you would like to summarize your testimony, it will be placed in the record in full. Speak to us and speak to one another. Good morning, sir. The forum is yours.

STATEMENT OF ROBERT R. KILEY, CHAIRMAN, METROPOLITAN TRANSPORTATION AUTHORITY, NEW YORK, NY, ACCOMPANIED BY MORTIMER L. DOWNEY, EXECUTIVE DIRECTOR

Mr. KILEY. Mr. Chairman, thank you. My name is Robert Kiley and I am Chairman of the Metropolitan Transportation Authority of New York. To my left is Mort Downey, the MTA's Executive Director. I am delighted to be here today.

The first thing I wanted to do, Mr. Chairman, is to take advantage of the opportunity to express my appreciation and the MTA's appreciation to you for the role you've played over these many years in securing legislation that has been so beneficial to the MTA as well as to other transit systems around the country. As a member of the Budget Committee you have protected mass transit's funding level. I'm sorry that you have found yourself in a position where you have to be on the defensive, but that's been the story of life for the last seven or eight years and you've done splendidly in the trenches.

On the Finance Committee, you've played a major role—the instrumental role—in ensuring the retention of Safe Harbor Leasing, and on a number of occasions—maybe too many to count—you've been in the lead in fending off attacks on our ability to issue municipal bonds.

You were also instrumental in the passage of the gas tax legislation in 1982 and in applying a penny per gallon to the mass transit fund, so your record is second to none in the mass transit area. I'm sure that you will continue to take that position of leadership in the years ahead.

Senator MOYNIHAN. That's very generous.

Mr. KILEY. I know that my time is limited and that there are other people here who have a lot to say on the subject which brings us together. I do have a longer statement which I have already submitted for the record——

Senator MOYNIHAN. Which I have read and find fascinating.

Mr. KILEY. Just quickly, the MTA—for those here who may not be familiar with it—is a New York State-chartered public benefit corporation charged with the responsibility of providing subway, bus, and commuter rail transportation in New York City and the seven suburban counties surrounding it. That does not count two Connecticut counties that we serve by contract through the Metro-North rail service.

We serve one out of every three users of mass transit in the United States. We provide almost six million rides a day, or over a billion and a half a year.

The replacement cost for MTA's equipment and facilities is estimated to be at least $75 billion. That's probably a very conservative figure. Until a $16-billion, 10-year capital program began to revitalize our infrastructure in the middle years of this decade, much of that stock was crumbling to the point of utter uselessness, particularly our subway system in the city. Just four years ago, for example, trains were derailing on the average of once every 18 days. We had go-slow orders on decayed track in at least 400 places around the system; that would result in 75 percent slowdowns at those particular points. Graffiti had covered the entire subway car fleet for more than 10 years, and—it almost goes without saying—ridership plummeted to half of what it was in the 1940's.

What has become perhaps the largest single purpose public works renewal project in the history of the country has brought, I think most people would agree, an unmistakable reversal of that subway decline. By the end of 1987, 158 miles of track—nearly 25 percent of the total in the system—had been completely rebuilt. All the slow orders had been lifted, and life-threatening derailments had all but been eliminated. Approximately 2,800 cars in the 6,200-car fleet were new or thoroughly overhauled, and most of the remaining cars were receiving far better maintenance in shops that have essentially been rebuilt.

By the end of 1987, the subway fleet as a whole ran twice as reliably as it had in 1982, and the fleet's average number of miles traveled between breakdowns was at its highest level since May, 1975. More than three-quarters of the fleet is now graffiti-free and being kept that way.

In 1983, the 10 IRT lines, the oldest and most dilapidated on the subway, had the worst cars and track, the lowest reliability, and the most graffiti-scarred fleet. Capital program money was put to work first on the IRT lines, and by the end of 1987 the track was in good condition and nearly 85 percent of the IRT's cars were new or rebuilt and kept graffiti-free. Speeds were increased, intervals between trains shortened, and running times reduced.

We know that our customers appreciated these changes because average weekday ridership on the IRT increased by 4.2 percent in 1986 and 6.8 percent through October, 1987. For the system as a whole, average weekday ridership increased by 3.6 percent through the first 11 months of 1987. This is more than double the pace of 1986 and, when all the figures are in, may yield the highest level of average weekday ridership since 1974.

Senator MOYNIHAN. Congratulations.

Mr. KILEY. Thanks.

Senator MOYNIHAN. You've topped almost half the 1940 level. Mind you, you've lost your Saturday riders.

Mr. KILEY. That's true. That's one reason not often remarked upon for the reduction of ridership, the fact that we no longer have a six-day work week.

Senator MOYNIHAN. But that's impressive.

Mr. KILEY. It is impressive. It is a testament to the fact that large amounts of money committed to public works actually can be spent——

Senator MOYNIHAN. Can I ask you, without interrupting—we've recently read that there has been a fall-off in the number of automobiles coming into the city. Do you think there is some connection between the improvement in mass transit, rail transit, and that?

Mr. KILEY. I think it's clear that there is a connection. There's some disagreement over just how many fewer cars came into the city during 1987, but the numbers are strikingly similar to the increase in ridership on the subway system.

Senator MOYNIHAN. Could I ask you to see if you couldn't give us a piece of paper on that sometime? Our committee struggles with clean air issues, and the connection is so elemental.

Mr. KILEY. I'll not only give you the numbers that we have on automobile traffic into the central business district and our own ridership figures, but we'll give you some projections that we're making about our own ridership. We'll see if we can't even do some noodling about what impact that might have on automobile traffic.

[The information referred to follows:]

THE IMPLICATIONS OF DECLINING AUTO ENTRIES INTO MANHATTAN ON MTA RIDERSHIP POTENTIAL

For the first time in over a decade, entries into the Manhattan CBD by auto, truck and taxi have declined substantially. Between 1985 and 1986 approximately 36,900 (or 3.2 percent) fewer people entered by vehicle over a twenty four hour period.

During this same period the total number of persons commuting into Manhattan by public transit increased by 2.8 percent or approximately 91,000. In fact, all increases in CBD entries were carried by two modes, subway (up 5.2 percent or 86,132 passengers), and suburban rail, (up 2.5 percent, or 5,392 passengers).

- o In 1987, the MTA established the goals of increasing subway ridership 15 percent, and MTA system ridership 10 percent, by 1991. Therefore, the modal shift trend is important.

The total number of entries into the CBD has been leveling off while transit's share is increasing.

- o Overall approximately 24,000 additional persons entered the CBD between 1985 and 1986, up only .7 percent.

The 3.2 percent decline in people entering by vehicle is the culmination of a three year shift in travel preference in favor of the commuter rail and subway modes. This shift, particularly with respect to the subway system, coincides with MTA's efforts to return transit to a state of good repair.

- o During the early 1980's persons entering by vehicle increased by an average of 4.7 percent per year.

- o At the same time, subway CBD entries were declining as a consequence of the system's state of disrepair.

- o A turn-around began to build in 1985 as the first elements of the capital program were implemented. Between 1985 and 1986, subway use systemwide was up .8 percent or 8.2 million additional riders. Subway ridership increased again in 1986 by 2.0 percent, and rose by 3.2 percent in 1987.

Transit infrastructure renewal has been critical. In fact, MTA ridership may have increased earlier if the public transit infrastructure had been in a state of good repair. Recent ridership trends illustrate this cause/effect relationship.

- o Subway services with 50 percent or more new or overhauled equipment posted a ridership increase of 12.2 percent for the first six months of 1987 compared to the same period in 1984. This represents an increase of 147,255 new riders.

- o Subway users within the CBD show a definite preference for lines where capital improvements have been made. Average weekday ridership on the IRT system, where new equipment has been assigned, was up 6.8 percent in 1987.

- Additionally, over the last fourteen months rapid transit ridership has grown three times faster than CBD employment (a key variable linked to trip-making behavior).

Nationwide, the demand for mobility will remain strong into the 21st century. That demand will be regionwide, emphasizing intra suburban travel as well as the traditional suburb to center city commute. Infrastructure development and renewal to meet these demands will be critical.

- The journey to work will continue to dominate. The size of the workforce has increased faster than overall population. The primary cause of this trend is the ascendence of the "baby-boom" generation, that in 1980 comprised 42 percent of the all U.S. workers.

- Suburb-to-suburb commuting has emerged as a major journey to work pattern. Intra suburban work trips now represent about one-third of all metropolitan area commuting, growing 58 percent between 1960 and 1980. At the same time, suburb-to-central city travel grew 25 percent. Given the above, future transportation infrastructure programs must be comprehensive in nature.

The problems associated with the auto as the dominant travel mode, will continue to emphasize the need for transit solutions.

- 87 percent of American households owned at least one car in 1980. Further, two or more car ownership was evidenced in the majority of U.S. households.

- Nationally, the number of cars is multiplying twice as fast as the population growth.

- Traffic congestion will increase. The Federal Highway Administration projects that vehicle delay due to congestion will increase by 400 percent on urban freeways from 1985 to 2005. Central City congestion is projected to increase by 8 percent per year.

- Increased auto use has resulted in a deterioration in air quality. As a result, major cities throughout the nation continue to violate clean air standards.

- Petroleum resources are shrinking worldwide as transportation, particularly automobiles, account for 65 percent of current oil consumption. Mass transit continues to be the most energy-efficient, pollution-limiting travel mode.

Public transit will continue to be critical to meeting the travel needs of the New York City metropolitan area. Infrastructure renewal and the maintenance of a state of good repair are the highest transit priorities.

- Transit dependency in the New York area is significant. In fact, nationwide, 9 percent of the households are without an automobile as compared to 49 percent in New York City alone.

- o Workforce in the MTA region is projected to increase by 2.3 million from 1980 to 2000 (a 6.3 percent increase). Infrastructure improvements are critical to enabling the MTA to meet the future demand for mobility that will accompany this growing workforce.

- o Regular replacement and overhaul of rolling stock will need continued financial support.

- o Track work and resignaling programs must be funded to continue to provide safe competitive service.

- o The rehabilitation of major terminals and stations throughout the MTA network is critical to increasing the attractiveness of public transit as an alternative to the automobile.

- o As the overall capacity of the system reaches maximum utilization in the future, fleet expansion and related support facilities will be required.

    - Where bottlenecks prevent effective operation, additional transfer facilities and route reconfigurations will be needed.

    - Initiatives that generate new capacity may be required as demand exceeds the system's ability to supply efficient, effective service.

    - Maintaining the momentum of the MTA's existing renewal efforts is absolutely essential. Barriers to that effort, such as the disrepair of the Manhattan and Williamsburg Bridges, must be removed. Federal infrastructure assistance here is critical.

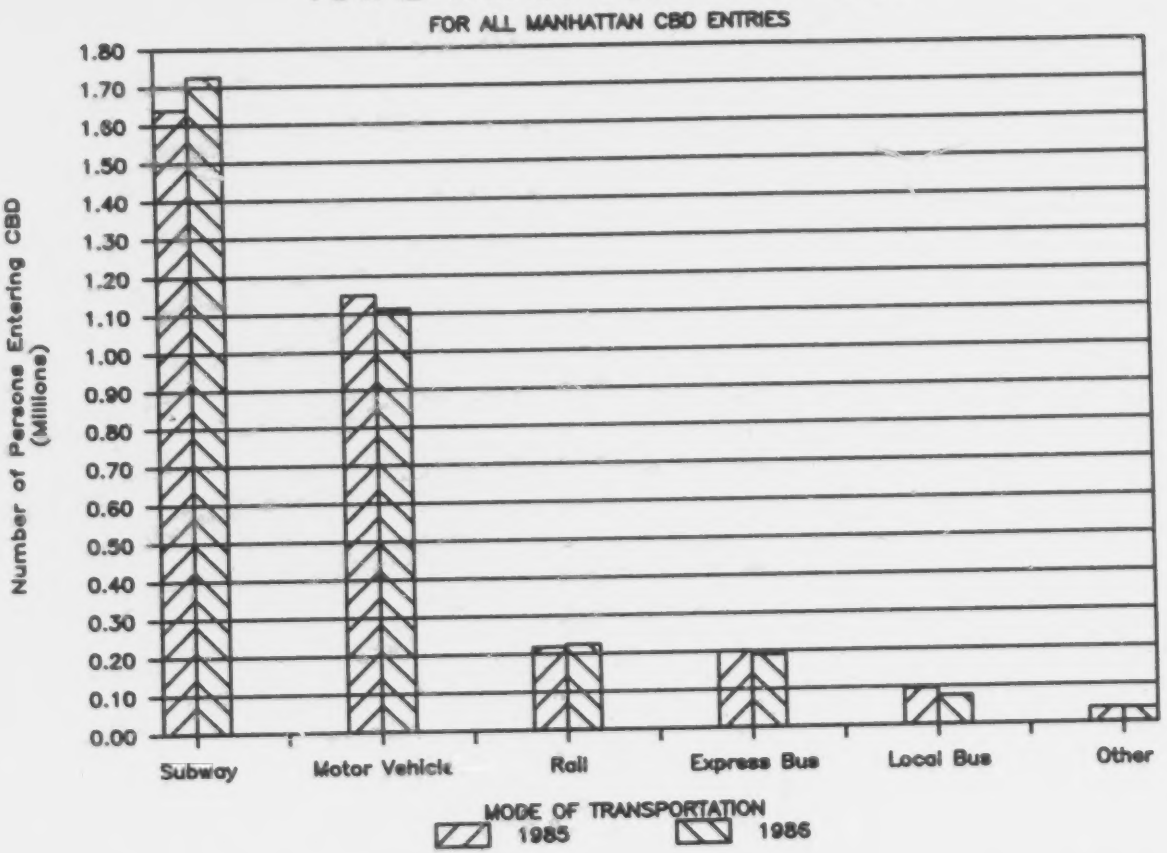
Conclusion

Declining Manhattan auto entries signal a new opportunity for transit to meet the region's growing mobility needs in larger measure than at any time in the recent past. The timing of this modal shift is particularly auspicious as the MTA is striving to increase ridership as an agency-wide strategic goal.

The ability of the MTA system to service increasing demand is dependent upon infrastructure renewal and maintenance. Continued federal support of the MTA's rebuilding effort is critical.

Planning Department
2/9/88

Attachment: Total trips: 1985 vs. 1986 (Graphic)


TOTAL TRIPS: 1985 VS. 1986
FOR ALL MANHATTAN CBD ENTRIES
Number of Persons Entering CBD (Millions)
1.80
1.70
1.60
1.50
1.40
1.30
1.20
1.10
1.00
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
Subway
Motor Vehicle
Rail
Express Bus
Local Bus
Other
MODE OF TRANSPORTATION
1985
1986

REVENUE BASED RIDERSHIP PROJECTIONS THROUGH 1991

	YEAR	LONG ISLAND RAIL ROAD		METRO-NORTH COMMUTER RAILROAD	TRANSIT AUTHORITY SURFACE DIVISION	TRANSIT AUTHORITY RAPID DIVISION
(A)	1987	71,575,263	(B)	53,429,274	488,896,740	1,055,465,905
	1988	76,213,443		54,693,114	498,895,695	1,095,848,584
	1989	76,666,601		55,768,689	488,273,116	1,120,302,639
	1990	75,336,595		55,882,543	473,939,043	1,143,841,548
	1991	76,634,001		57,239,961	458,666,209	1,184,132,413

(A) - Based on actual data through 9/87.
(B) - Reflects 13 day strike in January, 1987.

Mr. KILEY. The current year, 1988, will witness the greatest concentration of capital work since the subway was originally built. Another 1,000 new or rebuilt cars will be placed in service. Major rebuilding of track and structures will take place in every borough in which the system runs, as well as several large-scale station modernizations and restorative work on stations throughout the city. It will also be the turning point for the IND and BMT lines.

The story that I just told about the IRT from 1983 to 1987 should be replicated on the IND and BMT between now and 1991, which will mark the conclusion of our second five-year capital program.

I should note that massive capital expenditures to repair and replace transit infrastructure are having other impacts on our region. Our capital program is estimated to be generating almost 15,000 jobs at any point in time in New York State.

Thanks to sound management of capital investments, the Transit Authority's infrastructure and its service to customers have at last begun to return to acceptability. We're not there yet, but we're clearly on the way back. Although many key components will have reached a state of good repair by 1991, some—including most of our subway stations—will not reach it by the year 2006, even at current levels of constant dollar funding. And by "current levels," I'm talking about a capital program of some $1.5 billion each year.

The Federal role in meeting our infrastructure needs can't be understated for the MTA and for transit systems throughout the country. Federal funding for public transit expanded significantly for 20 years under 5 Presidents until 1981, when it came to a near halt. The consequences of underinvestment are felt every day.

There are many ways that Federal help for transit infrastructure can be provided as an effective supplement to the current urban mass transit assistance program or to new forms of transportation aid that may emerge in the post-Interstate era. Congress, for example, could encourage local investment by easing the limitations on debt refunding, as well as easing the interest burdens and arbitrage restrictions placed on tax-exempt financing.

Legislation to create a general infrastructure rebuilding program, with transit as an eligible purpose, is—to our way of thinking—essential. One attractive form it could take is the establishment of a low-cost loan program to support local initiatives, perhaps to come out of a Federal revolving fund, with the difference between interest payments and Federal Government costs provided as a subsidy to the fund.

Those of us who run transit systems were comforted by the authorization last year of a strong mass transit program as part of the Surface Transportation Assistance Act through fiscal year 1991. Nevertheless, we are well aware that 1988 brings unusual responsibility and an unprecedented opportunity to shape the national transit agenda well past the turn of the century. This agenda can enable public transit to achieve its long-term potential as a mainstay of America's economy and an important contributor to the Nation's environmental well-being.

To create a vision of a program that can achieve these ends, the American Public Transit Association has formed a task force on public transit for the 21st century called Transit 2000. I am privi-

leged to chair the group in its efforts to examine and articulate the developments and promise of our industry.

The premise underlying our studies is that good mass transit brings our Nation a host of economic and social benefits, and that the full extent of these benefits can be realized only if more Americans elect to use it. Inevitably, persuading them to do so may require more than merely rebuilding what already exists today. As we invest in infrastructure we must be aware of the need to make public transit a practical, economical, and environmentally attractive alternative to automobile travel. We must forge a broader perspective, building long-term capacity, and differentiating our products, just as business has done in recent years. And just as business has formed many partnerships with government, public transit, if it is to thrive, requires a continued strong Federal role in financing and an expanded responsibility on the part of States and localities in what has become and should remain a partnership.

In closing, Mr. Chairman, I want to thank you, as I said at the beginning of my remarks, for your vigilance and your support over these years. I want to thank you for taking the initiative here today.

Let me just add my enthusiasm for the new technology that you were describing. I can't think of a better candidate for its application than the northeast corridor. At the same time that the Federal Government first got involved in public transit across the country, it was getting involved in what was to have been a major program of expenditure and revitalization of the passenger railroad running between Baltimore and Boston. Many years and many dollars later, while we've seen some improvement, the change has not been anything like what the authors of the events of the mid-1960's had hoped. Perhaps the new technology could make a difference in this area.

Senator MOYNIHAN. We're going to find out.

One of the things that we're supposed to know is that you want to be on the edge of technology. We grant the Japanese their bullet train down to Osaka, but they realign the rails every night. The French have that train that goes from Paris to Marseilles which is a fast train. I think the Royal Scotsman made its way from London to Edinburgh at about the same rate of speed 70 years ago; you know, it's just getting the last bit of efficiency you can out of a machine that was fully developed by the 1840's—well, electrification might have changed it, but it was a first-half-of-the-19th-century idea. We need a first-half-of-the-21st-century idea. In trying to take those 19th century railroads and making them as good as they were, we weren't able to do it. I think it's in part because of the kind of energies that get attracted to that effort. I like to think that a new principle of transportation might engage people in ways that it previously hasn't, but in the meantime you have to move a third of the mass transit ridership every day in the city.

Mass transit has made the city possible. Two things made this city possible. The first was the water supply. Old Tammany, in its days of uttermost disdain by all the right-thinking people, built the finest municipal water supply in the world. They built the first aqueduct since 5th century Rome. It brought water down from the Catskills in that great "V" tube that they carved in the granite

under the Hudson. It just sends that water shooting up to the fifth floor of all those buildings in Manhattan and the South Bronx, and that's how the density was made possible, by water. And movement was made possible by the IRT and the Third Avenue El. So absent them, you don't have the island of Manhattan. If you don't keep at them, as we have noticed—the water supply is out of sight; I'm glad you mentioned it, but it's not always out of sight.

Mr. KILEY. Well, I was going to say that we've had two major water main breaks. The two great public works you mentioned conflicted with one another because the water main breaks stopped the IRT service, which underscores a peculiar point about Americans, that they're great builders but they don't always take care of things after they've done the original job.

Senator MOYNIHAN. I want to say to this panel and anyone in the audience, there is a prize—I'll get the bill passed—for a person who can figure out how to name a maintenance program after an incumbent elected official. [Laughter.]

If you could do that, we'd have a lot more—think about it. If you can produce those two capital programs that you've done, you can think of a way to get the Honorable—somebody, Hoopus and Spleek—water main maintenance program award, and——

Mr. KILEY. How about the Moynihan Wheel Truing Machine?

Senator MOYNIHAN. Something such.

Let's stay on the question of financing. Mr. Gambaccini, we welcome you, sir, as an official of a great invention of the 1920's between Governor Smith and his counterpart in New Jersey, the Port Authority. You've got some charts there.

STATEMENT OF LOUIS GAMBACCINI, ASSISTANT EXECUTIVE DIRECTOR, PORT AUTHORITY OF NEW YORK AND NEW JERSEY

Mr. GAMBACCINI. Mr. Chairman, let me open by expressing on behalf of the Port Authority and tens of thousands of commuters from the west our great thanks to you for your recent help in facilitating the legislation in Washington to assist us in expediting the siting of a ferry terminal in lower Manhattan. We regard that as of great significance.

Senator MOYNIHAN. A bit of old technology.

Mr. GAMBACCINI. Yes. It is reinvented, reintroduced old technology, much like light rail is reintroduction of the old trolley car. But we are very appreciative of your excellent efforts and success in that effort.

Let me also compliment you and thank you for convening this hearing, which we think is entirely appropriate and timely. Bob Kiley mentioned his role in "Transit 2000"; we perceive a threshold development that is underway now at the national level in a variety of different forums that is looking to the longer-term future, and particularly into the next century. Bob mentioned Transit 2000, which is the venture of the American Public Transit Association (APTA) Officials. AASHTO (American Association of State Highway & Transportation Officials) is undertaking a similar project, "2020."

Senator MOYNIHAN. And you're vice-chairman of the Transportation Research Board of the National Association?

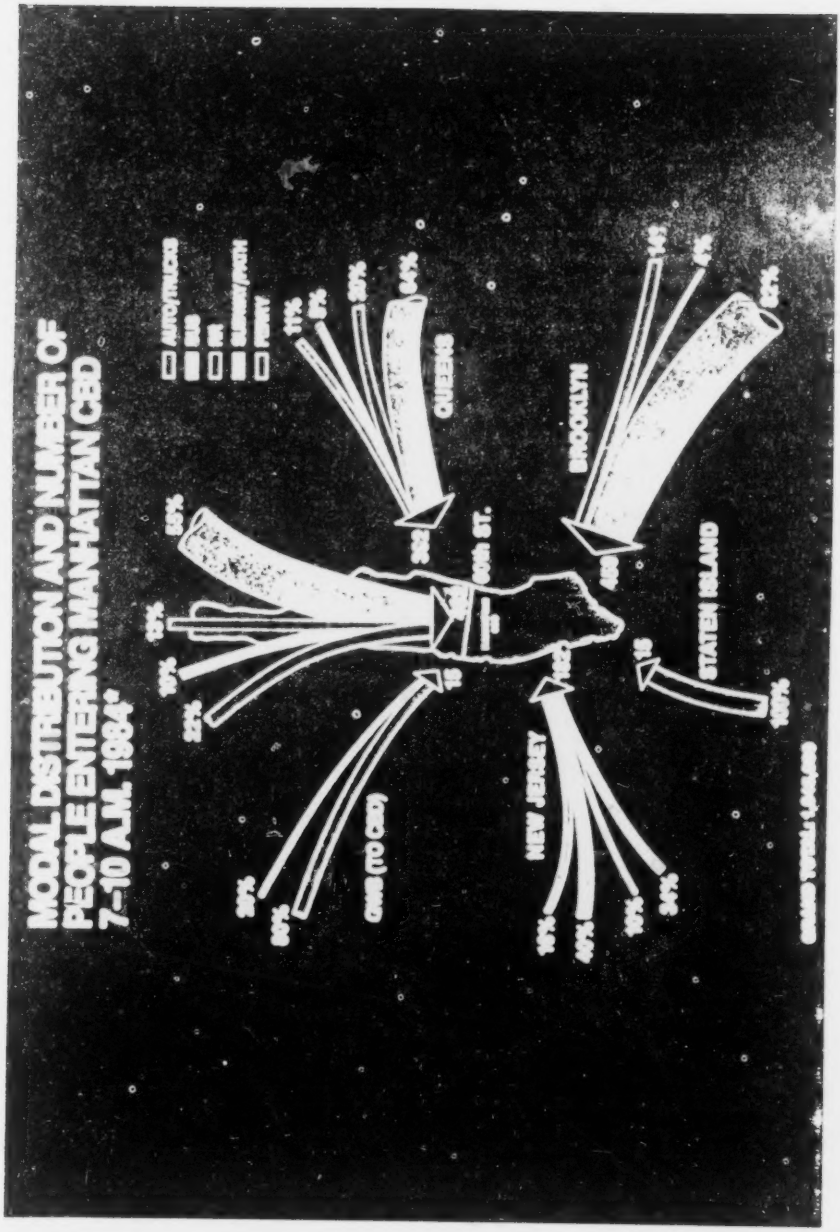
Mr. GAMBACCINI. Yes, as of its annual meeting last week. It is clear to me that there is a growing restiveness in the Transportation Research Board that is responsive to the dynamic changes in transportation, a blurring of the modal differences. There has been a revolution through deregulation; but most importantly, in preparing for growth and continuing to buttress the economy, it is essential that we now work very carefully to build new capacity into all of our systems. And this is particularly so in respect to urban transportation.

What I would like to do is very briefly touch on some of the highlights of our perception of this region and its current condition, and then lead into some thoughts about the Federal role.

Senator MOYNIHAN. Fine.

Mr. GAMBACCINI. I would say that the overarching theme should be, and is, integration. As I mentioned, there's a blurring of modal focus. I think there's less concern or less interest in biases about the focuses, and this is partly a function of congestion. No longer can any single entity exist in isolation. In this region, virtually our entire surface transportation systems and infrastructure are operating at or over capacity. It is also aggravated by deregulation and other dynamic changes that are at work, a couple of which I will mention in terms of demography of the region. But more and more, our focus must be mobility on the surface; that is, less concern with individual modes or routes or operating entities.

[Chart follows:]


MODAL DISTRIBUTION AND NUMBER OF PEOPLE ENTERING MANHATTAN CBD 7–10 A.M. 1984*
AUTO/TRUCK
BUS
BRIDGE/TUNNEL
FERRY
QUEENS
BROOKLYN
STATEN ISLAND
NEW JERSEY
60th ST.

Mr. GAMBACCINI. Integration is an overarching issue also through many other themes. Certainly, Federal, State, and local officials are more concerned about mobility than they are about favoring a particular mode as the pressures build on funding and on mobility. The private and public sector, both in supporting the economy as well as finding opportunities for joint venture and assuring continued support to economic growth, are moving in that direction as well.

In this region, economic growth has been happening everywhere at once, particularly in the last decade. After a decade of relative leveling of economic growth through the 1970's, the 1980's are a booming decade and the projections are that that will continue into the next century.

We have invested heavily in this region in coping strategies. I don't mean to minimize them—in fact, my hat is off to Bob Kiley and the superb progress in rehabilitating the MTA—but to a large extent, while the results are dramatic at N.J. Transit, PATH, all of the MTA properties, it is a restoration in kind of what has been there. The commitment has been on the order of $30 billion to transportation improvement over the past decade in both transit and highway, considerably increased over prior decades, at least the nearer prior decades. But I would certainly support your view that there has been, when compared to the first half century, substantial disinvestment——

Senator MOYNIHAN. There has been.

Mr. GAMBACCINI [continuing]. Over the last three decades, without question.

We are at a point, though, where we must prepare ourselves for the next century. We will continue to cope over the next 5 to 10 years in serving what we see as both present and future growth in that timeframe, but we've got to focus on how we handle the pressures of growth in the period of the late 1990's and into the next century.

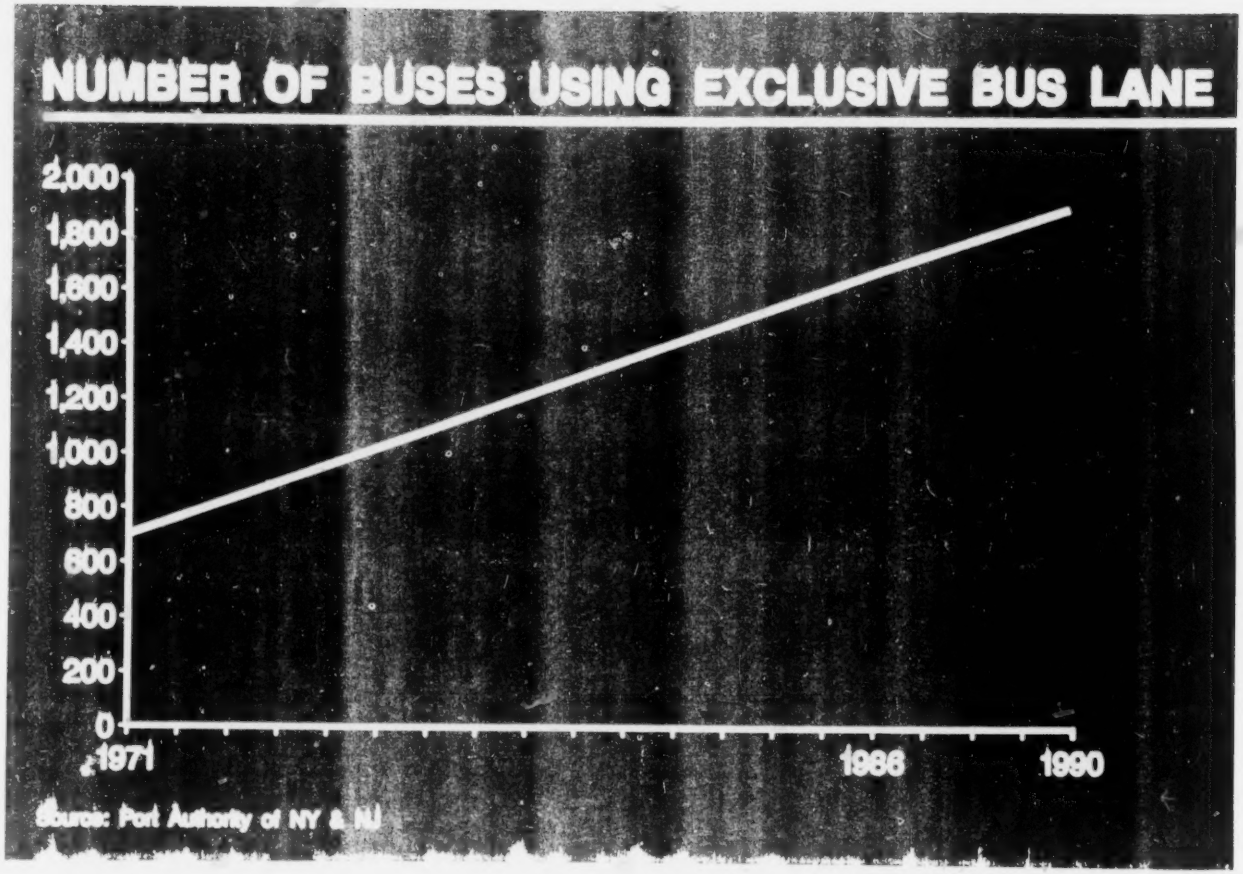
We are very blessed, if you will look at the board on the left, there, by a unique, extraordinary region with a vital transit infrastructure. There are about 1.5 million people in the three hours in the morning that come into the central business district of Manhattan, 84 percent of them come by mass transit. Indeed, we have really survived and been able to support the kind of economic growth that we've experienced because of the existence and improvement in mass transit.

During this period, transit has strengthened its role as the main transportation link. The Port Authority has supported the mass transit strategy as the dominant strategy in its overall program. In our 5-year, $5.6 billion capital program, $1.5 billion is devoted to surface transportation; $1.2 billion to rehabilitation, three-quarters of which is mass transit; and another $300 million to new capacity, including restoration of ferry service.

The second board, the one to the right, demonstrates the importance of building on existing assets. In a large sense, we have recycled the Lincoln Tunnel from an automobile facility to a mass transit facility. The curve there shows that since the exclusive bus lane was introduced in 1971, we have increased from 700 to 1,700 buses on that one lane. We are carrying 72,000 people on that one lane in

those three hours, as against 17,000 on three automobile lanes in the Lincoln Tunnel. Indeed, that 72,000 is greater than the entire car system handles during the peak three hours.

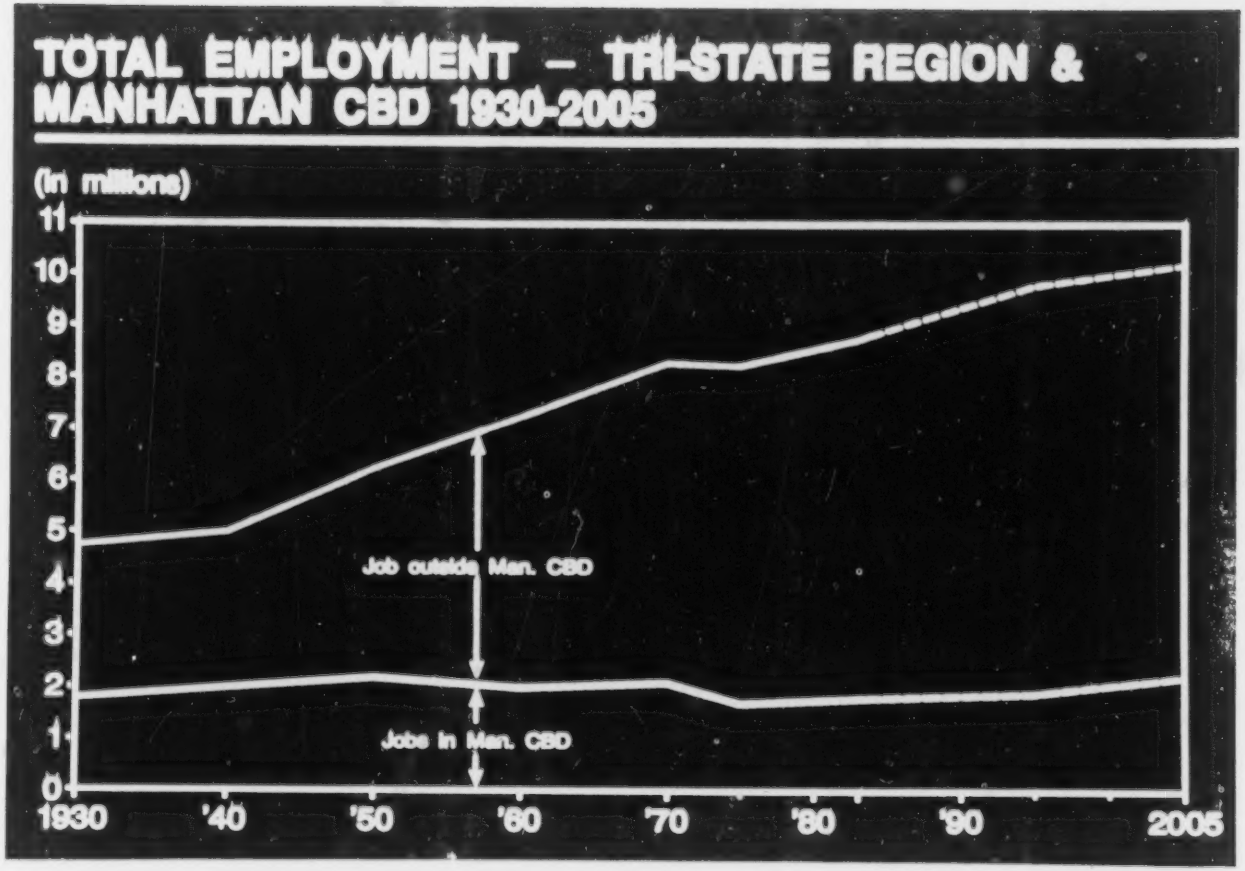
[Chart follows:]


NUMBER OF BUSES USING EXCLUSIVE BUS LANE
2,000
1,800
1,600
1,400
1,200
1,000
800
600
400
200
0
1971
1986
1990
Source: Port Authority of NY & NJ

Mr. GAMBACCINI. So it is a dramatic example of what can be done, given the pressure, and providing the opportunities for service to get greater and greater efficiency out of existing facilities, and I submit that we must continue to exhaust our opportunities to do that across the board.

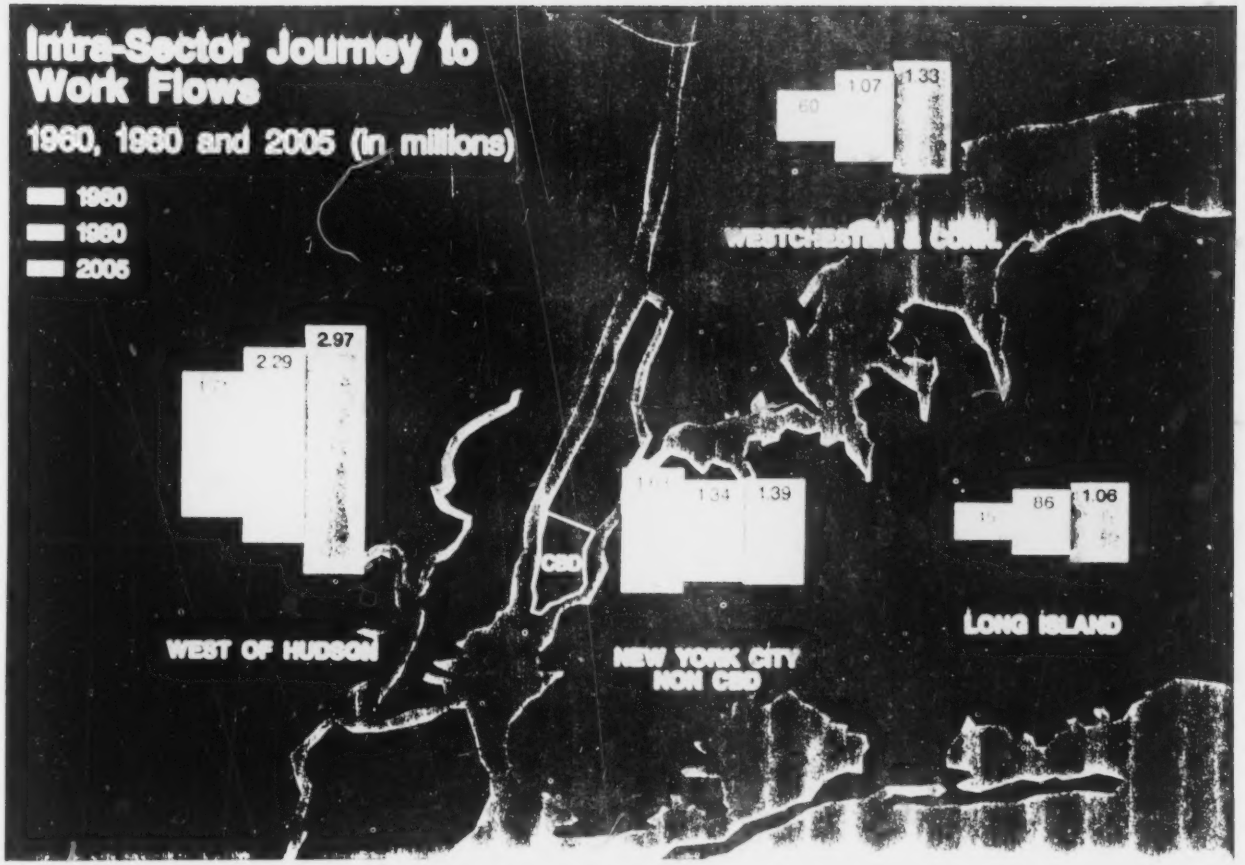
Most of the growth in the last 10 years has been occurring outside of the central business district, in housing starts as well as jobs. Jobs have increased in the central business district of Manhattan but have increased at a far greater rate in the suburban counties. The board on the left—the yellow line shows jobs in the central business district of Manhattan, and the orange, the upper curve, is all the suburbs. The suburban growth has been phenomenal, so much so that no longer can they be considered the "bedroom of the region" but rather have really become the dominant economic force in the region. That is not to minimize the importance of the central business district, which continues to increase in jobs and in transportation demand increases from year to year. But it is one of those not-so-subtle dynamic changes that is changing the nature of the challenge of transportation.

[Chart follows:]


TOTAL EMPLOYMENT – TRI-STATE REGION & MANHATTAN CBD 1930-2005
(In millions)
11
10
9
8
7
6
5
4
3
2
1
0
Job outside Man. CBD
Jobs in Man. CBD
1930
'40
'50
'60
'70
'80
'90
2005

Mr. GAMBACCINI. The board on the right shows the rate of growth of intrasector travel. You can see by the third bar in each of those clusters of three bars that the greatest growth is occurring outside of the central business district. This is a national phenomenon. A recent report by the ENO Foundation demonstrates that since the last census, the total volume of journey-to-work trips from suburb to suburb now exceeds the total volume of journey-to-work trips from suburb to city.

[Chart follows:]


Intra-Sector Journey to Work Flows
1960, 1980 and 2005 (in millions)
1960
1980
2005
2.97
2.29
1.07
1.33
1.34
1.39
.86
1.06
CBD
WEST OF HUDSON
NEW YORK CITY NON CBD
LONG ISLAND

Senator MOYNIHAN. You know, it is just so visible as one moves along the Long Island Expressway. You go from one large office building to another. There are woods between them, but they are still office buildings. I would have thought that that Manhattan curve suggests that you are now mature and stable.

As Mr. Kiley and Mr. Downey know, one of the problems is that the population of Manhattan today is only half of what it was in 1905. There used to be twice as many people living on this island as there are now. You had more customers then.

There are now more suburb-to-suburb transits than there are suburb-to-inner city.

Mr. GAMBACCINI. This represents a major challenge because most of the transit routes have been radial to the central business district. We have not provided the infrastructure to support that kind of booming suburb-to-suburb movement, either in transit or in housing.

Senator MOYNIHAN. There is a specific kind of capacity that we now are obviously going to need and don't have.

Mr. GAMBACCINI. Nor have we even begun to solve the riddle of how you provide the optimal kind of capacity. We don't know what that is. It's the increasing dispersion of jobs, the two-worker household with a wife who is going to another suburban point, but often making a number of stops for personal and family needs. This has compounded the character and nature of trips as well as the support systems to meet those needs.

Meanwhile, trucking has become ever more vital to the region. It now accounts for 90 percent of all the goods movement in the region, well ahead of the combination of marine and aviation. It is not to be minimized. It is an important element of the economy. Although in the peak period it is not a major factor, it is very much affected by congestion and by delay and has its ripple effect through the rest of the economy.

The region needs to make major investments, as do most metropolitan regions in this country, to meet the growth represented by some of these phenomena. Indeed, we haven't even yet met the basic continuing rehabilitation needs. Bob Kiley mentioned the $1.5 billion in needed continuing annual capital commitment to his system. The State of New York reports the need to virtually double its annual commitment merely to hold things together in the way of maintenance and rehabilitation of the existing system.

Among the other coping strategies we have been about are new coalitions to try to keep managing better that which we have. TRANSCOM is one such initiative. It is a nerve center to collect information from the entire region about the condition of the highway system, and then to disseminate that information to all of the 20 member agencies. This includes the three transit agencies as well as all the major highway entities. It is meant to assure a higher order of competent traffic management on a daily basis. We are in the process of computerizing construction coordination among all the entities. We are preparing diversionary plans—both of which projects, by the way, are being supported by Federal assistance.

A similar operating entity has been formed, called TRANSITCENTER, including the three major transit providers, a number of

private bus operators, and—most importantly—the private sector as well. One of the products of that kind of effort is a substantially improved snow emergency coordination and communication standard operating procedure.

Let me conclude by saying that from our perspective the Federal role, if anything, must be increased on a broad range. I certainly support the comments made by Bob Kiley with respect to continued support on mass transit. We believe the Federal Government must increase its commitment to national strategic thinking about metropolitan areas, to do a better job of looking at its disparate policies, taxation and a variety of subjects, to understand that these things are linked, that they cannot be compartmentalized as they have been in the past.

We think that there is a massive education job that must be undertaken with the public at large that must communicate the imperatives that there is no God-given or Constitutional right for commuters to continue to drive in single-occupant automobiles to free parking spaces provided by employers and to assume that there will be an endless provision of highway capacity, as well as—in some cases—redundant transit capacity that is underutilized and must be heavily subsidized.

Employers and developers must be part of this process. No longer can we indulge the rate of dispersion that has been represented by many of these trends in the past.

Metropolitan traffic congestion is a growing national crisis, and it has its implications on the economic well-being of this country. It is essential that this be recognized at the Federal level. We believe that the processes described in Project 2020 and Transit 2000 should, hopefully, give us some good coordinates and directions for the next round of the Surface Transportation Act with respect to the funding aspect and with respect to Federal policies.

We think that there should be a further encouragement of private investment in metropolitan transportation systems. An example—a very brief-lived Safe Harbor Leasing option certainly should be revived to further stimulate private investment in public transportation facilities.

We think there needs to be a recommitment to a level playing field with respect to tax policies affecting commutation. There is an imbalance when transit subsidies, in fact, are taxable income, for the most part, notwithstanding a modest exemption of recent date, where automobile subsidies for the most part are not considered taxable income. It produces and is a bias built into the process that favors one mode over another.

Finally, we believe that the Federal commitment to research should be continued and increased. We support your view that mag-lev is one of the technologies that should be given major national encouragement, particularly with respect to intercity and easing some of the shorter-distance Atlantic seaboard intercity travel pressures.

The Federal Government could be effective in supporting and encouraging other kinds of technology improvement, particularly, for example, in electronic toll collection, in electronic and multi-system transit fare collection. There could be significant breakthroughs in

the sense of mobility, freer-flowing traffic, and a whole host of other dividends that could flow from that.

Mr. Chairman, you have been a leader in identifying the national interests in maintaining America's public works infrastructure, and the region that you represent continues to be a leader in self-help and local effort. We see many problems and challenges before us; we believe that the Federal Government must intensify its activities to show innovative and creative Federal policies that would help each of us in the metropolitan areas in coping with these problems.

Thank you, Mr. Chairman.

Senator MOYNIHAN. Thank you. It can be a lonely exercise, as you know; I don't have to tell you that, Mr. Gambaccini, but there are those who love it.

Let's continue.

Mr. Warrington, we welcome you, sir. Mr. Warrington is Deputy Executive Director of New Jersey Transit; you're sort of Mr. Kiley's opposite number. Would that be right?

STATEMENT OF GEORGE WARRINGTON, DEPUTY EXECUTIVE DIRECTOR, NEW JERSEY TRANSIT

Mr. WARRINGTON. West of the Hudson, right.

Good morning, Mr. Chairman. My name, as you know, is George Warrington; I am Deputy Executive Director of New Jersey Transit. Jerome Premo, New Jersey Transit's Executive Director and Vice-Chairman of APTA, the American Public Transit Association, couldn't be here today due to a Board of Directors meeting. His written statement, which outlines national funding needs as well as the New Jersey perspective, has been submitted for the record and I will speak to you briefly here this morning on his behalf.

The written statement which Jerry submitted addresses nationwide transit infrastructure investments necessary for the 1988–1992 period, basically. Those needs total about $31.4 billion, or more than $6 billion per year. Current authorized funding levels total about $11.7 billion for the same time period, leaving about a $19 billion to $20 billion gap. That gap between funding needed to maintain today's level of service in the transit industries and authorized levels is sure to grow as deficit reduction remains a high priority, and appropriations emerge which are less than authorized levels, as occurred in fiscal year 1988.

Mr. Premo's testimony goes into much greater detail regarding national funding needs, as does testimony previously presented by APTA before Congressional committees.

The needs of the New York and New Jersey region clearly reflect the needs of the Nation. Within New Jersey alone we will need at least $250 million to $300 million a year to maintain the existing system, to begin to meet increased ridership demands on the transit system, which has been reborn, and to begin to accommodate future growth. In particular, New Jersey is investing very heavily in the increased capacity of the Trans-Hudson public transit network, which Lou Gambaccini briefly touched on earlier.

The ability to meet successfully that challenge of Trans-Hudson transportation requirements efficiently and effectively, transport-

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ing New Jersians into Manhattan, is essential to both the New Jersey and the Manhattan economies.

Besides addressing the Trans-Hudson transit needs, New Jersey is also gearing up significantly to invest in increasing intra-State mobility, which Lou Gambaccini also mentioned earlier, the suburb-to-suburb commute.

Skyrocketing residential, commercial, and economic growth in New Jersey in particular has contributed to suburban congestion throughout the State as it has across the Nation, as noted in last week's Time Magazine. In New Jersey we are exploring a host of transit alternatives to begin to meet those kinds of demands. As Lou indicated earlier, it is extraordinarily difficult and we don't have a quick fix.

In New Jersey there are two creative infrastructure funding mechanisms in place which we would like to propose, perhaps, as models for Federal infrastructure to follow. The first is our Transportation Trust Fund, which was just renewed this past week and signed into law by the Governor the day before yesterday, which was renewed for the next seven years through the dedication of an additional $0.025 State gasoline tax. Since 1984, this Transportation Trust Fund has financed nearly $1 billion worth of highway and transit infrastructure improvements in the State of New Jersey. Dedicated gasoline taxes are used to repay bonds issued by the Transportation Fund, and in the 1985 to 1987 period were coupled with additional State appropriations, contributions by independent toll road authorities, and heavy truck user fees. The Trust Fund is basically intended to be a simple and flexible long-term approach to State investment in public transportation. We are beginning to make that commitment to the basics in New Jersey. The goal is for the Fund's bonding cycle to be completed every 12 to 17 years, with new bonds being issued as the old bonds are retired. This will provide a stable capital funding source for New Jersey's transportation needs, we believe, well into the 21st century.

Senator MOYNIHAN. Could you help me here? The Trust Fund is built up, but you don't spend out of it? You finance bonds through it?

Mr. WARRINGTON. Yes, through the dedicated revenues.

Senator MOYNIHAN. And what is the contribution of the revenues to the bonds? Do you shave the interest? Is that basically the point? Do you get the bonds out at a lesser interest which is subsidized, or what?

Mr. WARRINGTON. I'm not quite sure I understand the question.

Senator MOYNIHAN. Tell me how the bonds get issued.

Mr. WARRINGTON. They are basically 12- to 17-year bonds, issued on a rotating basis.

Senator MOYNIHAN. I see. The leverage is that the revenue into the system is such that you can——

Mr. WARRINGTON. You can guarantee the bonds on a rotating cycle. Absolutely.

Another variation on that is what's called the New Jersey Waste Water Treatment Trust, or the Environmental Trust, which works much more on a pure revolving fund basis. Financed through a voter-approved bond issue which is the initial funding source, the Trust Fund makes interest-free or low-interest loans to local gov-

ernments, sort of along the lines that Mr. Kiley was talking about earlier.

Senator MOYNIHAN. They are going to go nationally, I suppose, at the end of the clean water era.

Mr. WARRINGTON. A portion of the funding for the trust is held in a reserve fund against the trust, and they borrow to make loans to local governments substantially below the market rates. The revolving loan concept works in New Jersey and could be considered, as you discussed, in a national infrastructure funding bank.

In conclusion, Mr. Chairman, I'd like to emphasize the need for transit requirements to be included in any Federal infrastructure program. A Federal-State-local-private sector partnership is essential from both a regional and a national perspective. Given the $19.7 billion gap alluded to earlier between current transit capital needs and funding availability at the current time, a national infrastructure bank should be in addition to and clearly not a substitute for traditional transit program funding.

Furthermore, a Federal infrastructure funding program must be conceived with adequate flexibility to ensure that State, local, and Federal programs are coordinated and clearly work in tandem. States like New Jersey which have already made commitments—recently through the earlier trust fund renewal, just this past week—should be able to integrate these existing programs with a Federal infrastructure finance program.

In conclusion, Mr. Chairman, we would like to thank you for this opportunity to share with you both the ideas that we have in New Jersey, and our needs as well, which are quite significant.

Senator MOYNIHAN. Thank you, Mr. Warrington, and I thank Mr. Premo for preparing this.

We'll get back to the infrastructure bank, but first we're going to hear from Mr. Arcuri, who comes down to us from Utica.

STATEMENT OF CARMEN F. ARCURI, GENERAL MANAGER, UTICA TRANSIT AUTHORITY, UTICA, NEW YORK

Mr. ARCURI. Thank you, Mr. Chairman.

First of all, I won't read my text because you have a copy of it.

Senator MOYNIHAN. We do, and we will put it in the record. We will be happy to do it.

Mr. ARCURI. I was able to see you when you were in Ilion, New York, a few months back. While we didn't converse, we did get some information to your people.

Senator MOYNIHAN. If you will recall, I made the claim that I was the first person in recorded history to get lost in downtown Ilion.

Mr. ARCURI. Let me say this about ourselves, Utica Transit Authority carries as many passengers in 1 year as New York City carries in 1 day, so you can have some idea as to our size. We are considered one of the properties of upstate New York that has a population of under 200,000 in the service area. Our service area accommodates about 165,000 people. The city of Utica, Rome, Binghamton, Elmira, Poughkeepsie, Watertown, Glens Falls are some of the 25 properties in upstate New York that are treated as part of the national areas under 200,000 population. Our concern right now is

that we were told we would be receiving a 32 percent increase in our funding under the reauthorization bill, H.R. 2, however, I understand that it has been lowered 8 or 9 percent. That's going to be a considerable hardship upon the small transit properties. Specially to Utica Transit Authority it will mean about a $100,000 cut. My total budget is around $3 million, so a $100,000 cut is pretty serious. The Federal Government has already cut our program by $200,000.

Five years ago U.T.A. received $700,000 a year from the Federal Government. We are now receiving less than $500,000, we bit the bullet and made cuts and sacrifices. However, it has created hardships for our clientele, the bus riders. We've kept our budget under $3 million for the past two years, but we're bursting at the seams. We need to do some things and we can't do them.

We are looking to use these additional funds for operating needs, it is optional to use these monies for capital or for operating. Some will have to use it for capital, but most properties need it for operating expenses.

Let me mention another thing about New York State that I feel pretty proud of. We have an association of small transit operators in New York State, and we asked the larger properties to join us. They joined us. They accepted one vote, and we work very well with them. They have been very helpful to the Small Transit Association, and we think we have the kind of cooperation in New York State that you should be proud of and that we're also proud of, we are doing things for each other.

Senator MOYNIHAN. You mean that Kiley, there, has one vote——

Mr. KILEY. Just one vote.

Senator MOYNIHAN [continuing]. And Arcuri has one vote? Like New York State and North Dakota?

Mr. ARCURI. It's good for us. Again, I could call Dave Gunn and say, "Dave, do you have this or that?" and he is quick to respond and that's good. Syracuse, Albany, Rochester and Buffalo have also been helpful. It's the kind of cooperation that saves money for us, and also enables us to take advantage of the larger properties talents and the smaller properties have also been helpful to the very small properties.

The other problem that we have, and we addressed that problem when we were in Ilion, is the charter regulations. We're very concerned. Charter service probably could brings up to $50,000 a year in revenue for U.T.A. Just accommodating governmental groups and private/nonprofit groups that need our service, we can provide that service for about $25 an hour. Private operators have to charge $45. We don't want to compete with them. The people who need our service are the poor people and the private/nonprofit groups, they cannot afford this costs ($45 an hour) and are forced to go without service.

Senator MOYNIHAN. From the kind of work contract that you had with Oneida County Social Services?

Mr. ARCURI. That's right. And the Boy Scouts, we accommodate them all summer long. We take them up to Tupper Lake and to Cedar Lake. The affluent seniors can take care of themselves, but the poorer seniors cannot get about. They have their food programs

during the day and their shopping programs that we easily accommodate.

We would hope that UMTA would take some action on this quickly. Again, it's been passed by the Senate and the House, so it's a matter now for UMTA to move it, and we would hope that UMTA would move quickly.

Senator MOYNIHAN. I know that my colleague, Senator D'Amato, will take concern with that.

Mr. ARCURI. Thank you Senator.

Senator MOYNIHAN. Thank you, and I want to ask the group now to help me with a couple of things.

First of all, I found that Chicago Fed letter that was referred to. I hope that you share that around your association. That is a very powerful piece of analysis; the correlation between public investment and general productivity. It's a very powerfully argued rate of return on capital. It has perked up, obviously, but that's a pretty powerful 20-year trend that shows up—I see Mort Downey agreeing—and there does not seem to be any question but that we have been disinvesting. I'm just not ever going to be good enough at these things to really recognize disinvestment when I see it, but certainly the rate of capital formation is down. And corresponding with capital formation is capital usage. You have to be consuming it at the same time.

We've gotten into some bad habits here, and they will catch up with us as they caught up with the New York City subway system. It was a different political thing; the five-cent fare became a totem of New York politics, and it worked wonderfully well for 30 years and then, one day, the subway system just collapsed. Then it worked out not to have been such a good idea, but by that time the mayors had come and gone.

There is some lore—I don't know how statistical—but in 4th and 5th century Greece, the olive groves were planted under the dictators. It takes 27 years for an olive tree to bear, and then it works for 400 years. But the democracies didn't get many olive groves planted. The dictators expected to be there forever; they weren't, but they didn't know that at the time. They could make that transition.

In Mr. Premo's testimony, he speaks of an infrastructure bank. I keep hearing financing from you. You need a financing system; you mentioned getting back to Safe Harbor Leasing; you spoke of the problems when the municipal bond market closed. That happened after the 1986 tax bill, didn't it?

Mr. WARRINGTON. That's right.

Senator MOYNIHAN. Yes. I'm on the Finance Committee and was on the conference committee that produced that bill. I don't think we intended to close the municipal markets. Treasury hasn't come to us and said what's happened. I see a good friend, Richard Eaton, in the room, who is a bond attorney that I want to hear from.

What we need is a source of financing that you can come to in Washington for leverage loans of your own, and we need to look at the tax code in terms of the methods that have been effective just in your own direct financing. It's a combination of those two things. And then finally, there's the direct Federal grant and subsidy program.

We're going to have to find a dedicated source of revenue as you've done in New Jersey, which we haven't done in New York. We've got some bond issues but they're recurrent things.

Would you give some idea of what you think the level of Federal Government financing ought to be? You speak of a $20 billion gap in transit over—what, 5 years, was that? So if you had $5 billion a year available to you in financing, you could handle that. That's not, in fact, that much money when we're running a $4.5 trillion GNP. Actually, that's not a large sum. We surely need to have about a $50 billion a year program, don't we? Mr. Gambaccini, you work with these big numbers. Wouldn't you say that?

Don't we need about a $50 billion a year program?

Mr. GAMBACCINI. Senator, I'm not really in a position to answer that specifically. I know the numbers that have been cited have been prepared largely by surveys by each of the entities, the American Public Transit Association and AASHTO.

I was just whispering to Bob Kiley because that number in fact is to meet the current and projected unmet needs, not system expansion. I think one of the biggest riddles is, how do we continue to assure mobility, given some of these dynamic forces, and what is the——

Senator MOYNIHAN. The $20 billion is, in effect, maintenance?

Mr. GAMBACCINI. Yes.

Senator MOYNIHAN. I mean, you keep your system; at a rate of about $4 billion a year, you keep what you have. Spend less, and you have less.

Mr. GAMBACCINI. Yes. By the statistics that Bob Kiley cited and what New York State has indicated, in general it looks like we need to virtually double the level of commitment to capital across the board, both highway and transit, just to hold things reasonably well maintained.

Senator MOYNIHAN. Well, you always learn something when you put a number to it; it looks right to you or it looks too big or too little. Your judgment is—taking the American economy as a unit—in terms of what we're putting into infrastructure, we are disinvesting and we need to double it just to maintain ourselves? To maintain ourselves, we need to double it?

Mr. GAMBACCINI. It's a very bold kind of response to say that, but——

Senator MOYNIHAN. Yes. That's what we're talking about. And then you have to ask what you want to add to your capital stock. With those two calculations you've come up with some idea of where we ought to be.

Does that make sense to you, gentlemen?

Mr. GAMBACCINI. Yes.

Senator MOYNIHAN. Mr. Warrington?

Mr. WARRINGTON. Yes.

Senator MOYNIHAN. Mr. Arcuri?

Mr. ARCURI. Yes.

Senator MOYNIHAN. All right.

Our job is to get that into numbers. We're going to try to have legislation in the next month or so, and if you see any Presidential candidates, tell them we said hello.

Thank you very much, gentlemen. Let me adjourn just for a moment so I can thank you personally. We stand in recess for five minutes.

[Recess.]

Senator MOYNIHAN. The committee will resume the hearing. We now have a long-awaited and especially interesting presentation. We're going to hear first from Dr. Henry Kolm, Chairman, Management Executive Committee, Electromagnetic Launch Research. With him is another scientific associate, Dr. Francis Moon, Director, School of Mechanical and Aerospace Engineering at Cornell University; Dr. Moon, we are very happy to have you.

I wanted to note for the record that Dr. Jim Powell of Brookhaven National Laboratory, who was an early contributor to magnetic levitation transportation technology—we got in touch with him too late for him to be here today. He is going to prepare a statement which will be part of today's record, and I'm sure that both of you gentlemen, being scientists in this field, know Jim Powell. (See p. 118.)

To follow our normal sequence, Dr. Kolm, I will ask you to lead off.

STATEMENT OF HENRY KOLM, CHAIRMAN, MANAGEMENT EXECUTIVE COMMITTEE, ELECTROMAGNETIC LAUNCH RESEARCH, INC.

Dr. KOLM. Thank you, Senator Moynihan. I welcome the opportunity to testify on behalf of a technology which I think is every bit as important as the last three innovations in transportation, having been the train in 1830, the automobile in 1900, and air travel in the 1930's and 1940's.

I think it's important to recognize two things. First of all, the technology was invented here, not in Germany or Japan as is commonly stated in the press. It was invented at Brookhaven and at Princeton and Cornell and at MIT and at Ford Motor Company and at Stanford Research Institute, and it's pathetic that we are in a mode now where we invent things and people abroad implement them. It used to be the other way around. The Germans invented the Otto engine and Henry Ford put it in everybody's car.

The testimony that I am about to give is available in pamphlet form, along with some technical background information from Scientific American and elsewhere, and I invite anyone in the press or anyone interested to help themselves. If we run out, I will send you more.

Senator MOYNIHAN. We will make that part of the record, too. This is a very serious record.

Dr. KOLM. The first point I'd like to make is that train technology is very obsolete. It's 19th century technology. Trains were invented when people lived in population centers and were connected by straight lines across the prairies. Trains are very obsolete things. Trains have enormous girders for the purpose of concentrating the payload on two axle pads so that they can be carried by steel wheels under enormous pressure, which then has to be distributed over the ground by ties and ballast. That was a nice way to get around in the 1830's; it's no longer applicable now.

Trains carry a thousand people once or twice an hour. This makes them a very ponderous, heavy thing that can't go around curves and can't make very steep grades. A railroad right of way is much straighter than an Interstate highway right of way. The railroads cannot follow Interstate highways, nor can we build any new railroad rights of way in this crowded planet we live on. They require heavy bridges, enormous tunnel structures if they can't go on grades, and perhaps the worst problem is their inability to maneuver in the present environment as evidenced by the fact that when trains were proposed for the Florida corridor, which goes from Tampa to Orlando to Miami, it turned out to need over 350 grade crossings in order to make that right of way work. Grade crossings in a high speed transportation system are completely unacceptable.

Railroads were invented 200 years ago. The new technology has come along since the 1960's. It's time to build for the 21st century, not to resurrect 19th century technology.

Magneplane is the first really practical concept which distilled out of all of these initial research concepts. Whether or not it is exactly the thing that is implemented is not the important issue. The important issue is that something like Magneplane is inevitable technology, just like the wheel was inevitable, and if we don't do it here in this country it will be done somewhere else and we will have to follow.

The basic concept of the Magneplane is that instead of having a thousand passengers once or twice an hour, it handles a hundred passengers once or twice a minute. This means the vehicles and the guideway are very small and light. They can be accommodated on masts or posts. They have no problem with rights of way; they simply don't need any of their own. They can follow Interstate highway systems——

Senator MOYNIHAN. They can follow Interstate highway systems?

Dr. KOLM. Yes. I have some artist's versions of what a Magneplane installation might look like, both near a station in an urban area and alongside an Interstate highway.

Senator MOYNIHAN. Just the elemental community politics of getting a new right of way in this society is getting to be impossible, but we own the Interstate system. It's ours.

Dr. KOLM. I have a list of the features that distinguish Magneplane from the railroads.

The train is a heavy structure; the Magneplane is a light fuselage. The vehicle is essentially the fuselage of a 737 jet. It carries about 150 people.

Trains carry a thousand passengers twice an hour; Magneplane carries a hundred passengers twice a minute. It has a capacity of 72,000 passengers one way in a 12-hour day.

Instead of stopping everywhere, Magneplanes can go non-stop. If you consider the northeast corridor from Boston to Washington, there are 18 stops that need to be served. No matter how fast the train goes, if it has to stop 18 times it isn't going to be very fast. It's going to spend 60 megawatts of power every time it stops accelerating the people who didn't want to stop.

Magneplane vehicles are coupled electronically instead of mechanically, so each vehicle can simply stop at its destination. The vehicle, on the hour, might go non-stop Boston to Washington,

while 30 seconds later a vehicle might stop once in one of the New York stations, and so forth. It has the same feature which made airline flying so popular, that you essentially go non-stop.

Magneplanes are not loaded on line like railways. You never think of loading an airplane on runway; the runway is shared. So Magneplane, similarly, is designed to be removed from the main trunk for loading and unloading.

The reasonable maximum speed turns out to be something like 224 miles an hour because at that speed the drag energy simply becomes too high to be reasonable. In other words, at 224 miles an hour it takes so much air drag that you wouldn't want it——

Senator MOYNIHAN. Is the air drag the vacuum you leave behind? Help me. You'll be horrified to learn that I'm sometime member of the President's Science Advisory Committee. That would really shake your faith in your colleagues.

When you say "air drag," I assume that you mean as you move at a certain speed, you create a vacuum behind you, and that's what the drag is?

Dr. KOLM. Right.

Senator MOYNIHAN. All right.

Dr. KOLM. Well, the conventional way——

Senator MOYNIHAN. And there's an efficiency curve; you might be able to run at 350, but the energy costs are not worth the extra speed?

Dr. MOON. Exactly. You also create a pressure in front of the train. The next time you're on the Metroliner and a train goes by, you'll feel an initial pressure pushing you away and then you'll feel a pressure sucking you back.

Senator MOYNIHAN. You have a wave in front of you, is that it?

Dr. MOON. That's right. So you have pressure in front and a vacuum in back.

Senator MOYNIHAN. Okay. Help this Senator; he understands very little.

Dr. KOLM. The only reason airplanes can go 500 miles an hour is that they go above most of the atmosphere.

Senator MOYNIHAN. Right.

Dr. KOLM. At ground level, 224 miles an hour—the magic figure—turns out to be the maximum reasonable speed to go.

Now, the energy required—let me just address that issue for a minute. Conventional railroads use 60 megawatts, typically, of wayside power. Magneplanes use only about one-tenth as much, six megawatts, because the vehicles are much smaller and because instead of using it once or twice an hour it uses that power capacity once or twice a minute.

Senator MOYNIHAN. Let's see. You're using a unit of electricity; I think in Btu's. You have this railroad train with ten times as many people. Does that correspond to the ten times as much energy, or is it energy per person?

Dr. KOLM. Roughly, yes. The only difference is that the cost of power is essentially capital-intensive. In other words, you're paying more for having the power available than you are for using it. So the cost of installing a new system depends on how much power you have to be able to furnish each train.

Now, since railways carry 1,000 people and ten times as much power, they have to have a much larger power installation. It sits idle most of the time, you see. It sits idle.

Senator MOYNIHAN. Oh, you're talking about electrified railroads?

Dr. KOLM. Yes.

Senator MOYNIHAN. All right. Okay.

Dr. KOLM. So electrified railways require a very large amount of power which they only use once or twice an hour, when a train goes by. The magnetic levitation system we envisage would use one-tenth the power, but it would use it once or twice a minute at a much higher rate.

Vehicles would not be coupled mechanically. They would be coupled electronically, and that's what makes it possible to do that. It's also what makes it possible to service many stations without everybody stopping everywhere all the time.

Railway systems have hard rail contact, which is essentially what limits their speed. Magneplanes fly about 12 inches above an aluminum trough, supported resiliently and free to bank. In other words, they are much more like a bobsled or a surfboard than they are like a train. The vehicles themselves are very inexpensive. They are passive; they have no motor. All they have is three superconducting magnets, so you can afford to have many, many vehicles—

Senator MOYNIHAN. You won't mind if I interrupt? And Dr. Moon, would you just join in, too, when I'm obviously getting very confused?

When you say "superconductivity" what you mean is the technology that is currently available, liquid hydrogen?

Dr. KOLM. Yes.

Senator MOYNIHAN. And it may yet be another stage of technology with the new ceramics?

Dr. KOLM. We built a fully operational system in 1972 which has been seen on many NOVA films which used superconducting magnets that were available back then. In fact, you could build it with permanent magnets. I have a little demonstration here that shows how simple the concept really is.

This is nothing but a permanent magnet on the end of an aluminum rod. Aluminum doesn't interact with magnets. The spinning aluminum disk produces a positive force against the magnet. This magnet floats about an inch above the aluminum disk and is very resilient and supportive. If I push it close, the resistance increases enormously so as to avoid contact, and this is the force that makes it very simple. I don't want people to think that magnetic levitation is an esoteric and very complicated thing. On the contrary, it's a very natural and simple thing. This magnet produces lift at the expense of drag, just like an airplane wing produces lift at the expense of drag. It is simply the electromagnetic equivalent of aerodynamic flight.

Senator MOYNIHAN. That's nicely put, isn't it?

Dr. KOLM. This aluminum is in the form of a trough, and the magnet would be absolutely guided by the trough. It would also be free to bank, like an airplane, so that when it negotiates curves at

high speed there will be no lateral force on your passengers, which would be unacceptable.

Magnetic levitation is every bit as natural as airplanes were, and this is one of the things that has not been understood generally. I welcome anyone with interest to come up here and play with this system after we're through.

Senator MOYNIHAN. Well, thank you. This high school student will do just that.

Dr. KOLM. The motor which propels the Magneplane, which is in the center of this aluminum trough, is also a very simple thing. I have a piece here of what we built in 1972—we have 400 feet of this in a laboratory near Boston. This produces a traveling wave; you just supply it with alternating current. The wave which makes the magnetic field goes up-down, up-down, and it moves, so the vehicle rides this wave very much like a surfboard. The wave is synchronized with the vehicle by position information transmitted from the vehicle to the ground. It is much easier to transmit information than electric current.

That's how Magneplane works. It controls its own surf, think of it that way. So it is a very natural thing. It's not an esoteric, high technology thing that may or may not work. We already know that it works. I would be happy to send these video tapes to anyone who would like to see tests of the actual system as they were done in 1974. It is explained more fully in articles appended to this testimony.

Now, the fact that Magneplane is self-banking makes it possible to negotiate overpasses and curves that will allow you to follow and use the Interstate right of way. It eliminates the need for purchasing more right of way.

That was perhaps the most important feature when they were trying to make the railroads take turns quickly. They just couldn't do it. Also, Magneplane goes on land or underground; on the ground, it requires much less of a tunnel and much less construction.

Magneplane lifts off at about 20 miles per hour and, just like an airplane, it lands on wheels at the edge of the guideway.

Of course, it eventually produces friction from the electric resistance of this system. You can figure that out for yourself. The currents move around the wire producing a magnetic field which shifts to the next turn of the meandes and it goes up, so the train goes a little farther, which produces a field that ultimately goes up and down—or north and south, whichever way you want to look at it. As the current shifts from wire to wire it will move, and the speed at which it will move simply depends on the frequency.

The waves can accelerate or decelerate the vehicle. Once they're on the computer, it controls all vehicles in the system.

Senator MOYNIHAN. And deceleration, how does that work?

Dr. KOLM. When the waves push back—you can make the waves push back or you can make the waves push forward; you can also make the waves push up and down. That's important for ride quality control.

The problem with building a Magneplane is not to produce the lift or the performance. The real problem is to produce shock absorbers because if we have this vehicle flying 12 inches above the

guideway it can be a really uncomfortable, bumpy ride. In the 1970's we went so far as to build an active shock absorber into the Magneplane system.

Senator MOYNIHAN. But as someone who has been to Lincoln Laboratory, if you can define that kind of problem you can solve it?

Dr. KOLM. Right.

Senator MOYNIHAN. It's just putting resources into a method, right.

Dr. KOLM. This will be the first time we have put it all together. This got started in 1970. We got support from MIT, Raytheon and Duco, and some contributions from Alcoa, a total of $350,000 until 1973, at which time the National Science Foundation provided approximately $650,000, so the total monies spent on the project were $1 million. Then the project was discontinued by the Government in 1975. The Office of Management and Budget announced that it would drop all support for high speed ground transportation.

Senator MOYNIHAN. Was that part of the Cambridge Transportation Research Center?

Well, if I may say, I was Assistant to the President for Urban Affairs and then Counselor to the President, and the question came up of what to do with that building. I got it to be the Center for Transportation Studies and Linear Concepts.

Let me assure you that whatever President Nixon knew and when he knew it may be a very widely-discussed issue, but he never knew anything about the $1.1 million worth of research in transportation. That's at least a minimum of three zeroes missing. But it's just plain OMB and the new Secretary of Transportation. That's why I put it there. I mean, I literally put it there. I had been the Director of the Joint Center for Urban Studies at MIT and Harvard; I knew enough to know that if you put it there, something would happen.

All right. Those gentlemen you were just listening to are extraordinarily capable public servants. They have found the money to rebuild the subway system and the bus system and meet the transportation system of this region. What we haven't been able to do is find a place in this country that makes buses any more or makes subway cars. And what we've got to work out in the politics of these things is an arrangement whereby—a company up in Quebec, Bombardier, if they would come down and put up a plant in Auburn and one in Vermont, we could buy their products. But they didn't.

Thank you very much, Dr. Kolm. I wonder if we could ask your colleague, Dr. Moon, to give his testimony.

Now I know something. That center that we set up in 1969 was closed and we stopped this and announced that we were not going to do it. No wonder that the Japanese and the Germans are doing it.

Dr. KOLM. Secretary of Transportation Brinegar announced there would no longer be any research on anything which didn't have a payoff within 1 year.

Senator MOYNIHAN. Within 1 year?

Dr. KOLM. Within one year.

Senator MOYNIHAN. All right. When you know things like this, and you ask why we have to go to Japan for half our subway cars

and Quebec for the other half—that's just good engineering; it's nothing in the way of technology.

Professor Moon, we welcome you, sir. You obviously know each other, as scientists do.

May I have the record show that Dr. Kolm is, of course, a physicist and was a member of the resident staff at Lincoln Lab from 1954 to 1960. You were Senior Scientist in the Department of Aeronautics and Astronautics at the Massachusetts Institute of Technology and at the National Magnet Laboratory.

Dr. Moon is more committed to the traditions of the laboratory and the university, and we welcome you, sir. I would point out to you both that you're in almost precisely the same field.

STATEMENT OF FRANCIS C. MOON, DIRECTOR, SCHOOL OF MECHANICAL AND AEROSPACE ENGINEERING, CORNELL UNIVERSITY

Dr. MOON. Thank you, Senator Moynihan.

Let me say that this bill comes at a very crucial time for this technology of magnetic transportation. It is crucial from two points of view. One, from the needs of our transportation sector, but also in terms of the U.S. transportation manufacturing industry. If we fail to develop this technology, not only do we not serve the public in terms of improving transportation, but we will lose manufacturing jobs in the transportation manufacturing sector, most likely to the Germans or the Japanese.

The dream of traveling above the earth with no gravity or with gravity suspended is an old one; in fact, this being the bicentennial of the Constitution, in my letter to you I quoted from Benjamin Franklin in which he imagined that someday science would be able to discover a way to transport people without touching the earth.

Today that science is no longer fiction, but the future may not be found in the United States. It may be found in Japan or Germany if we don't act very quickly. This proposed bill represents a first step toward bringing the United States back into transportation leadership before the next century.

This bill also comes at a time of great scientific excitement about new discoveries in superconductivity.

Senator MOYNIHAN. Yes. And this will connect, won't it? If you can use the magnets you were using, you can now envision a higher order of magnitude, more powerful and more efficient, or whatever?

Dr. MOON. If the new materials continue to develop, this technology will be brought out of high-technology and into the medium-tech realm where we will not have to worry about liquid helium.

Senator MOYNIHAN. Which has got to be costly, yes.

Dr. MOON. But even with the conventional superconducting, materials superconductivity has already made an impact on new technologies, one of them being magnetic levitation for high-speed ground transportation.

Now, as has been pointed out, the overcrowded skies at major U.S. airports demonstrate the need for additional transportation options. A significant percentage of that air traffic is between cities that are less than 500 miles apart, and superconducting mag-lev

transport at 300 miles an hour is an ideal solution to provide additional capacity to our city-to-city transportation systems.

As has already been noted, the United States started this research back in the 1960's——

Senator MOYNIHAN. I'm going to take the liberty of interrupting. You say 300, and you say 224. Is that a difference?

Dr. MOON. There are a number of different mag-lev systems that one can conceive of, and depending on what size you make the fuselage and how close you make the fuselage run to the track, you will get different amounts of drag. So different mag-lev systems can be optimized to run somewhere between 200 and 300 miles an hour.

Senator MOYNIHAN. You're sort of on the far edge, and maybe 224 is the ideal. You can do it, but it costs more.

Dr. MOON. The Japanese have already built a three-car train which has run over 200 miles an hour. They have built a one-car train that has run over 300 miles an hour. So it's not that we're talking about things in a laboratory today; we're talking about vehicles that have been built, both in Japan and in Germany, for the last 10 years—more than 10 years—with which they have demonstrated that this technology can work and can be very safe and efficient.

In 1978 and 1982 I was invited——

Senator MOYNIHAN. Could I just interrupt one moment? Your statement is in the record, but you state, "In fact, just last week I mothballed my mag-lev dynamics laboratory"?

Dr. MOON. Yes. I had a laboratory with a rotating wheel that was used to simulate mag-lev track. We studied the dynamics of a small levitated mag-lev model above it. I had originally built that lab at Princeton with funds from the National Science Foundation. Then I went to Cornell; we had funds from the Department of Transportation, but those funds ended around the late 1970's. I tried to keep the laboratory sort of under wraps, but I finally put the whole thing in storage. That was only last week, before I got your telephone call. So the laboratory is in storage.

Senator MOYNIHAN. Is it in Ithaca?

Dr. MOON. In Ithaca, yes.

Senator MOYNIHAN. The Department used to have a branch in Buffalo, didn't it?

Dr. MOON. That was the Cornell Aerolab, the Curtiss-Wright Aeronautical Corporation. Because of the problems in the early 1970's about coupling——

Senator MOYNIHAN. Oh, don't we know?

Dr. MOON. You understand——

Senator MOYNIHAN. I was there. That was going to be a radar building, wasn't it? The Draper Lab; that was going to be the Draper Lab, and we couldn't have that, so I thought I'd do something with it. What was that man's name, again? Brynegar?

Dr. KOLM. The Transportation Secretary.

Senator MOYNIHAN. Okay, and he was the fellow who wanted his research to pay off in 1 year?

All right, Dr. Moon. I just wanted to note that. And this obviously is not exactly the supercollider we were planning.

Dr. MOON. I just had a visit from the head of Japan's mag-lev project who, over the years, has visited my lab, just as I have vis-

ited Japan—Dr. Kyotani—and he and other Japanese engineers are now trying to market this new technology. He has been all over the world and has visited many States in the country, Florida and Nevada and California. They claim that their technology is now ready to be marketed, whereas we have yet to build any kind of a prototype in which we can get some kind of experience.

Dr. KOLM. May I inject a statement here? Their technology may be ready to be marketed, but they have done a disservice to this whole field because what they have is another railroad. It's simply a railroad that has substituted magnets for wheels. You might ask how it is that they were unable to use it for the Florida system.

It is a mistake to say that the Japanese are ahead of us. They are not. They have spent $700 million——

Senator MOYNIHAN. They've spent $700 million?

Dr. KOLM. Yes, $700 million, and it is not a viable system. It is just another railroad. It will do nothing that a railroad can't do.

Senator MOYNIHAN. Dr. Moon?

Dr. MOON. I would probably disagree with my colleague.

Senator MOYNIHAN. Okay. You wouldn't be colleagues if you both agreed. Then there would be one too many of you. [Laughter.]

Dr. MOON. Perhaps the Japanese system is not as creative as one might envision with this new technology, but certainly it has the capability of running between 200 and 300 miles an hour in a straight line.

But the point is that, for example, proposals for the Las Vegas-Los Angeles line have been made by the Japanese and the Germans who have competing mag-lev systems. The officials in Nevada and California could not find expertise in the United States to judge which of these technologies was the best, and they had to go to Canada. Canada had kept a group alive, studying magnetic levitation. They had to go to Canada to find expertise which would be able to tell the States of Nevada and California whether mag-lev would be a good solution.

So it's not just that we haven't done the research. We don't have the cadre of engineers and scientists to judge these particular systems. So there's a danger that some States—for example, Florida—may choose a conventional rail version, the French rail version or Swedish rail version, because they do not have the expertise to judge this new technology. They may invest billions of dollars in a 19th century technology instead of, as we mentioned before, looking forward to the 21st century.

Senator MOYNIHAN. That's extraordinary.

Dr. MOON. There have been meetings in Japan and around the world on magnetic levitation, There was one in 1985. This was called "Mag-Lev Transport 85."

Senator MOYNIHAN. Where was that?

Dr. MOON. It was in Tokyo.

Senator MOYNIHAN. In Tokyo?

Dr. MOON. There was only one paper from the United States, from Boeing Corporation. Their particular study had to do with mag-lev vehicles for low speed uses, airports and so forth. And I just learned that Boeing has terminated their project and has transmitted their data to Carnegie-Mellon University, which can use all the papers done on Boeing's ideas.

So right now we probably have nothing except for Dr. Kolm's work and his company, almost nothing going on in this technology. Again, last year there was a meeting in Canada; there was only one paper on magnetic technology from this country.

Dr. KOLM. I would like to add that in addition to Boeing, there are several aerospace companies who tried to innovate and lost a lot of money: Boeing, Grumman, United Technologies, the Aurora Corporation of San Diego, and TRW. They have all lost their money and given up because there is no national effort.

I was—and still am—Chairman of the Committee on Magnetic Levitation. When we were active in this field there were meetings in Toronto, in London. As I said, all this interest ended in 1975.

Senator MOYNIHAN. I make the simple point that there were two and a half social scientists, or whoever, that were members of PSAC. Herb Simon got a Nobel Prize, and Jim Culman, and I was the half. But I was the vice-chairman of the AAAS and was even a member of the board of directors of AAAS. I thought I'd left a transportation center up there in Cambridge looking pretty good, and I missed.

This almost defies belief. The way you describe it, the science is all done; this is the level of technology. Isn't that right? It's like when President Kennedy said we would go to the Moon. They knew how to do it; they just didn't have the machine that would work, but everything you needed to know about the universe and the solar system was there.

We're developing laser beams to zap Soviet missiles over the horizon, and in the meantime the Japanese and the Germans are doing this. And these are derisory sums that you mentioned.

Dr. KOLM. We could have kept abreast of what they were doing had we invested a measly $5 to $10 million a year in the last 15 years.

Senator MOYNIHAN. Yes.

Dr. KOLM. We are losing our security.

Senator MOYNIHAN. Is the Department of Defense not putting any money into this?

Dr. KOLM. No, they're not interested.

Senator MOYNIHAN. If I have one preoccupation with our defense, with our R&D, it's that here we are in the 1980's and we still haven't figured out a weapon to deal with that World War I device called the tank. We sit there paralyzed by the notion of all those Soviets; in the meantime we've got lasers going zap, boom, wham, you know, and we can't stop something like a tank.

Go ahead, Dr. Moon.

Dr. MOON. Let me just make two more points here.

First of all, I like your anecdote about the olive tree, and I wish to make a point about time scales. I think that in the last 20 years the United States has gotten used to what I call "microtechnology" in which, starting with the transistor, we come up with the chip. We have some development which occurs in Bell Labs or in IBM, and a year later we see a device. We can stick it in our ear and we can watch it on the screen or we can pick up the phone; we've been used to instant technological development, but these have been mainly from devices that have to do with microscopic electronics. When it comes to macrotechnologies—such as public infrastructure

and transportation and things like that—we have to talk about a different time scale. It takes 10 to 20 years to bring those new systems from the drawing board to operation, and we've lost the patience for that. Since President Kennedy's "man on the Moon" and maybe the Space Shuttle, we really haven't had a megaproject of this kind. I think we've lost patience with it. I think that if we're going to develop magnetic levitation for either low-speed or high-speed transportation, we have to think from now to the year 2000. It's that kind of commitment.

Senator MOYNIHAN. But you can reach out and touch the year 2000, if you think about it.

When you say "low speed" and "high speed," would you help me with that distinction?

Dr. MOON. The low speed—there are low-speed magnetic levitation systems which can move people within a city, or move people at airports. For example, there's a demonstration project in Birmingham right now which is a magnetically- suspended "people mover."

Senator MOYNIHAN. Birmingham in Britain?

Dr. MOON. Yes.

Senator MOYNIHAN. Oh. Well, I was going to say, let's get on a plane and go down and see it.

Dr. MOON. It goes 22 miles an hour.

Senator MOYNIHAN. Okay, 22 miles an hour, a people- mover? Okay. So you have all these ranges of uses.

Dr. MOON. And they're making money on it.

Senator MOYNIHAN. They're making money on it.

Dr. MOON. So let me suggest, then, that the path that we have to think of in terms of developing this technology is similar to developing a new aircraft. The time between the Comet jet, which was the first jet, to the 747 was approximately 15 years.

Senator MOYNIHAN. Right. The Comet flew in 1951 or——

Dr. MOON. I think 1954 was when the crashes occurred.

Senator MOYNIHAN. Well, the crashes were later, but the Comet was in 1951, and the 747——

Dr. MOON. In 1969 or 1970.

Senator MOYNIHAN. So you had 20 years to mature to the top of the food chain; you're not going to get any bigger than that.

Dr. MOON. What I was suggesting is that before we can ask an agency like the Department of Transportation to assess the feasibility of such a system, we have to build some technical and engineering know-how in this country in order to give this technology a fair chance.

Senator MOYNIHAN. Yes, let me ask two distinguished scientists, you can get engineers into this field; if you ever set your mind to get 1,000 engineers who really were up to speed on this, it would take you 12 months. You could take any good engineer and say, "Now, we're going to learn this this month." If you put your mind to doing it—you know what you're trying to teach them. You don't say, "Now, this is the little part here that we haven't figured out yet, some principle of electromagnetism for which we're awaiting a Nobel laureate." You know it. You've done it.

Dr. MOON. So I think it would take just 1 to 2 years to put together a group of people. I think it should involve industry as well as Government because I think industry has to begin to——

Senator MOYNIHAN. Well, we're at the top—Boeing and such are at the top of the line. They're not going to make any bigger airplanes. This is kind of an optimal moment. I remember that the fellow who designed the United States said it was the finest ship ever built and the finest ship that ever would be built. And he was right, you know.

You were saying, Dr. Kolm?

Dr. KOLM. There is an effort going on. There is a group at Argonne Laboratories, headed by a very bright young fellow named Larry Johnson, an economist, who has been studying transportation systems. He has concluded that the industry group most likely to support magnetic levitation systems are the airlines. If the airlines can get something like Magneplane to relieve their hub airports, then they will see fit to invest.

Senator MOYNIHAN. Mr. Sammat—I haven't introduced Dr. Sammat. Councilor Sammat just gave me a paper by Larry R. Johnson of the Center for Transportation Research at Argonne on the applications of high-temperature——

Dr. MOON. Let me just say that the State of New York has created an Institute for Superconductivity at State University of Buffalo. That institute is run by Dr. David Shaw, and it will solicit proposals from all over New York State. I will be involved in that institute. We are organizing a meeting in Buffalo on April 18th to 20th, and one of the sessions will highlight the applications of superconductivity to the transportation needs of this country.

Senator MOYNIHAN. Well, you ought to let us know.

Dr. MOON. In fact, Larry Johnson from Argonne will be there. We will have people from Canada, and we're hoping to get some Japanese to come. This will be in mid-April.

Senator MOYNIHAN. And this is an Institute for Superconductivity at Buffalo?

Dr. MOON. This was established with funds from the Exxon suit. The State of New York, in its wisdom, created an institute for studying technology that might benefit the public, as did the State of Texas.

Senator MOYNIHAN. Terrific, because at Alfred—they're doing extraordinary work. I was up there a while ago. And you're doing a lot, and down in Corning—New York is full of energies in this field.

Dr. MOON. We're a hotbed of superconductivity.

Senator MOYNIHAN. Well, we're looking disaster in the face, aren't we? We ought to do something. We sort of saw the premonitions in the Bombardier subway car and the Japanese Ittakasaka or whatever, and it's going to happen here. And that 747 that everybody has to have can turn out to be some other vehicle system.

It's very clear; you don't have to know anything to know that you can produce the engineering competence in this sector.

Dr. KOLM. There seems to be a big gap between pure science and technology. We can afford a supercollider, so why can't we afford to maintain our transportation systems?

Senator MOYNIHAN. This is elementally necessary stuff.

Okay. Go right ahead, sir.

Dr. MOON. If I could make just one more point to show how transparent the United States has been with regard to the new technology appearing in transportation. I just received a report from the National Research Council called "Directions in Engineering Research." If you open it up to the section on transportation systems you will find all kinds of suggestions for improving the maintenance or optimizing our present technology in transportation. There is not one mention in this distinguished report from scientists and engineers of the National Research Council which mentions magnetic levitation for transportation.

Senator MOYNIHAN. That's turning into a mechanic's manual. There's nothing wrong with mechanics, but we didn't establish the National Research Council in 1917 to do that.

I have a question on energy. This is just indulging myself at your expense if you will just be patient with me for one moment. I was out in San Diego a while ago giving a lecture at the medical school. I had a morning free before I had to get back, so I went down to the fleet—the fleet's always in in San Diego—and went aboard a new cruiser of the Aegis class of cruisers. It was a Sunday morning and I got the tour, the helicopter and the various systems, a pretty impressive thing, the missiles and the aiming and the controls and so forth. But the most striking thing was the required tour of the engine room. I was in the Navy 50 years ago, and an engine room is an engine room; it's where the black gang comes from. That was in the days of coal, but it didn't change that much in the days of oil.

I got down there and, my God, the color scheme of the engine room in the cruiser U.S.S. *Valley Forge* is the color scheme of an operating amphitheater at the College of Physicians and Surgeons. It's whites and grays. The powerplant is three DC-10 jet engines, and it moves at a flank speed of 30 knots with three engines. We use four to get 150 people from here to Chicago. I had no idea how much energy it takes to get that thing up in the air. I mean, if three engines can move a cruiser at 30 knots, jet travel for short distances has got to be a very marginally efficient use of energy, wouldn't you say?

Dr. MOON. The problem is that if you carry the powerplant with you, you have to pack it into a small place and it limits your options in terms of efficiency. The exciting thing about magnetic transportation is that you can distribute the power sources along the tracks. Not only that, we have created an all-oil-based transportation system—trucks, cars, airplanes, buses—whereas the magnetic levitation transportation system could be run on electric power which could use coal or natural gas or nuclear power. We have options.

Senator MOYNIHAN. Right.

Dr. MOON. But the present direction that we're going relies solely, except for small railroad use, almost exclusively on oil.

Senator MOYNIHAN. On oil.

Now, can I ask you one last question? Back in the early 1960's I was working on the Appalachian question in Washington, and we thought we might have some opportunity in terms of what was called "mine mouth generation," putting the electrical plant in

West Virginia at the mine and transporting the electricity, but it just turned out to be too costly. But superconductivity puts you within sight of electrical transmission systems that are long-distance, right?

Dr. KOLM. Well, there are capital investment problems. There is also the question about the energy needed for airplanes. An enormous amount of energy is involved in getting it up to altitude.

Senator MOYNIHAN. That's what I mean. If we could move at 220 miles an hour between here and Washington, we would in effect go twice as fast as the Eastern Shuttle. The Eastern Shuttle takes an hour.

If you remember, I mentioned earlier this article in U.S. News and World Report that our last new airport in the country was Dallas-Fort Worth in 1974, and that's 25 square miles.

Last question—I think you have answered it, Dr. Kolm, but I would ask you both. The Interstate system, given that there's more right of way there than you might think. We could reasonably think of fitting a magnetic levitation system into the Interstate?

Dr. KOLM. We definitely can.

Senator MOYNIHAN. And you, sir?

Dr. MOON. I think it's possible. You might have to redesign various overpasses, but it is possible, yes.

Senator MOYNIHAN. So you don't need that much more space for this sort of thing?

Dr. MOON. Oh, no.

Senator MOYNIHAN. Overpasses are nothing. But if we didn't have the Interstate system, you couldn't talk of building a new corridor through most parts of the country?

Dr. KOLM. We studied that very question, specifically in connection with the Florida system where it will follow Interstate 4 east-west and Interstate 95 north-south. It can be installed on the Interstate.

Senator MOYNIHAN. Well, I think that is a very powerful argument.

I can't tell you gentlemen how much we appreciate this. Members of our committee staff are all over the place. I should have asked you all up; I don't know why you are sitting back there on the benches.

I'm going to say that the hearing is now closed. The record will remain open for any additional statements. We want to express the great appreciation of the committee. We're in recess or else we would be in Washington; we're going to see more of you gentlemen. It is clear to me that we have to move this way. We just have to do this, and sometimes what you have to do, you do.

Thank you, John. Thank you, Andrew.

[Whereupon, at 11:45 a.m., the subcommittee was adjourned.]

[Statements submitted for the record follow:]

TESTIMONY OF ROBERT R. KILEY

CHAIRMAN

METROPOLITAN TRANSPORTATION AUTHORITY

OF THE STATE OF NEW YORK

BEFORE THE SUBCOMMITTEE ON WATER RESOURCES,

TRANSPORTATION, & INFRASTRUCTURE

OF THE UNITED STATES SENATE COMMITTEE

ON ENVIRONMENT AND PUBLIC WORKS

NEW YORK CITY, JANUARY 21, 1988

Submitted for the Hearing Record

INTRODUCTION

My name is Robert Kiley and I am chairman of New York's Metropolitan Transportation Authority (MTA). I would like to thank the members of this subcommittee for providing me with an opportunity to submit testimony on transit infrastructure needs.

The MTA, for those members of the subcommittee who may be unfamiliar with it, is a state-chartered, public-benefit corporation charged with the responsibility of providing subway, bus, and commuter rail transportation in New York City and seven suburban counties in New York State, as well as two Connecticut counties. The MTA serves approximately 5.8 million customers a day, 1.7 billion a year, one of every three users of mass transit nationwide. Our three major transit operating systems are the New York City Transit Authority, the Long Island Rail Road, and the Metro-North Commuter Railroad.

The magnitude of the MTA's infrastructure is concomitant with the transit services it provides. For example, the MTA network comprises 2,126 miles of track, 8,296 rail cars, 736 stations, and 4,079 buses. The replacement cost for the MTA's equipment and facilities is estimated to be at least $75 billion.

Though the MTA is by far the largest transit network in the nation, its problems and needs epitomize most of America's transit systems. I shall discuss those national needs later, as I describe the work of Transit 2000, the American Public Transit Association's Task Force on Public Transit for the 21st Century. But first, I would like to offer my assessment of the current and long-term transit needs in the MTA region and my observations about some of the ways the rebuilding of public transit may be financed.

BACKGROUND

All the infrastructure of the MTA, much of it neglected for years until a massive capital improvement program was begun earlier in this decade, is being brought to a state of good repair. It must be kept in that condition and replaced systematically as it reaches the end of its useful life. Having analyzed the network's components and their useful lives, we estimate it will require investments in excess of $1 billion per year for the next 20 years to replace those components on a life-cycle basis. Extraordinary costs to correct for past deferred maintenance, as well as costs to provide additional capacity or other efficiencies, must also be accommodated in financial plans. According to our calculations, our total needs will reach nearly $32 billion by the year 2006.

The MTA's capital plan is the largest non-federal public-works project in the country. In addition to rebuilding transit infrastructure it is creating 15,000 jobs in the State of New York at any time in the course of the program. New York City and its suburbs are not the only beneficiaries of the rebuilding effort; cities such as Buffalo, Elmira, Hornell -- all of which have companies and plants deeply involved in the program -- have received an economic boost from the work done to restore transit in our area.

Investments made to revitalize the MTA's infrastructure will pay for themselves many times over. They will contribute to the mobility of a region that can be crippled by vehicular congestion and air pollution, and they will provide safe, reliable, civilized transportation for people continually remaking the choice to live and work in metropolitan New York.

Initially approved by the New York State Legislature in 1981, the MTA's five-year capital program for 1982-86 was a response to to the previous underinvestment in the physical plant of the MTA's constituent agencies. For the ten years before the start of that program, the Transit Authority and the commuter railroads had spent an average of less than $400 million annually on capital improvements, compared with the $1 billion per year that would have been appropriate to keep the

systems in good repair. Moreover, much of the previous investment was directed toward new routes, instead of maintaining and improving existing ones.

The 1982-86 capital program allowed each of the agencies to make major improvements to their rolling stock and physical plants. While much of the work contained in the program is still under way, the systems' performance is responding to the stimulus of capital investment. The Transit Authority program has provided new and rebuilt cars and buses, major structural renewal, rehabilitation and expansion of shops and yards, and construction and rehabilitation of bus depots. The capital program has allowed the commuter railroads to bring most system components to a state of good repair, has provided additional capacity to accommodate increased ridership, has improved service levels, and has provided funding for normal, life-cycle replacement of components that are at or near the ends of their useful lives.

By the end of 1986 the capital program had provided $7.7 billion to start the process of regeneration. At the close of the year the capital program was authorized for another five years, and later funded at $8.6 billion.

TWENTY-YEAR NEEDS: 1987-2006

Although many key components will have reached a state of good repair by the year 1991, there will still be some Transit Authority components that will not reach that state by the year 2006, even at the current annual levels of constant dollar funding.

In May 1986 each MTA agency submitted an estimate of its 20-year capital needs, in constant 1986 dollars.

Tables 1 and 2 below show, for the Transit Authority and the commuter railroads, the years in which each major category of components is projected to achieve a state of good repair. The Transit Authority will not reach this state until after 2006; the LIRR will achieve this state in 1991; Metro-North will achieve it in 2004.

TABLE 1

YEAR STATE OF GOOD REPAIR IS REACHED
BY INVESTMENT CATEGORY: NYCTA

MTA CATEGORY	MAJOR COMPONENT	YEAR SGR IS REACHED
T-1 New Cars	Purchase 200 Cars per Year	1991
T-2 Car Overhaul	EOH	1988
	GOH	1991
T-3 Buses	New Buses	1986
T-4 Stations	Elevators	1996
	Platform and Roof Replacement	1997
	Escalators	2006
	Station Lighting Modernization	2006
	Rehab of Subway Stations	post-2006
	Rehab of Above Ground Stations	post-2006
T-5 Track	Contact Rail	1990
	Subway Track	1990
	Elevated Track	1991
	Welded Track	1991
	Surface Track	1992
	Mainline Switches & Crossovers	2005
T-6 Line Equipment	Circuit Breaker Houses	1987
	Ejectors	2001
	Fan Plants	2001
	Pump Rooms	2001
	Tunnel Lighting	2008
T-7 Structures	Standpipes and Discharge Lines	1996
	Elevated Structures Rehab.	2000
	Subway Tunnel Rehab.	2008
T-8 Signals	Antenna Cable	1998
	Telephone Cable	2004
	Signal Enclosures	2008
	Signal Equipment	2012
	Signal Cable	post-2006
T-9 Power	IND Substation Enclosures	1989
	IRT Substation Enclosures	1994
	BMT Substation Enclosures	1994
	IRT Substation Equipment	1996
	BMT Substation Equipment	1996
	IND Substation Equipment	1998

TABLE 2

YEAR SYSTEM COMPONENTS REACH A STATE OF GOOD REPAIR:
COMMUTER RAILROADS

YEAR	CATEGORY	MAJOR COMPONENT
Long Island Rail Road		
1985	Track	Installation of Welded Rail
1986	Cars	M-1 and Diesel-Coach Overhauls
1990	Signals & Communications	Penn Station Central Control
	Stations	Flatbush Avenue Terminal
	Line Structures	Viaducts
1991	Shop & Yards	Bridges and Buildings Shop
	Signals & Communications	Signal Power System
	Stations	Wooden Platform Replacements
Metro-North		
1988	Line Structures	Hudson Line Tunnel
1989	Rolling Stock	M-2 Overhauls
	Power	New Haven Catenary System
1993	Stations	125th Street Station
1991	Stations	GCT Plant
1995	Stations	GCT Passenger Facility
1998	Line Structures	Bridges
1999	Line Structures	Interlockings-Woodlawn
2000	Line Structures	Right-of-Way Drainage and Protection
2004	Line Structures	Park Avenue Viaduct

Figure 1 below shows, for the combined transit and commuter railroad network, the classification of the total needs into the following categories:

State of Good Repair (37% of total needs, or $11.7 billion): Projects necessary to correct for past deferred maintenance or to replace equipment that is beyond its useful life.

Normal Replacement (40% of total, or $12.8 billion):

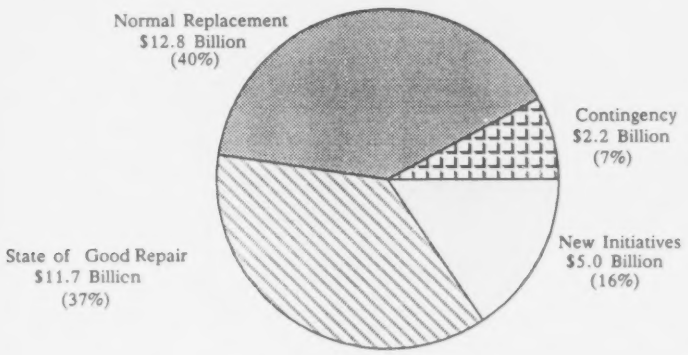
Projects to maintain the system in good repair by replacing components by the end of their useful lives.

New Initiatives (16% of total, or $5.0 billion): Projects that go beyond normal replacement by providing additional capacity to accommodate increased ridership, improving service quality for existing and future customers, or improving efficiency to reduce operating costs. Among these are the completion of the 63rd Street and Archer Avenue lines.

In addition, there is a contingency of $2.2 billion, or 7% of total needs, to fund emergencies or unforeseen additions that might arise.

FIGURE 1
MTA CAPITAL NEEDS BY NEEDS CATEGORY (1987-2006)

(1986 Dollars)



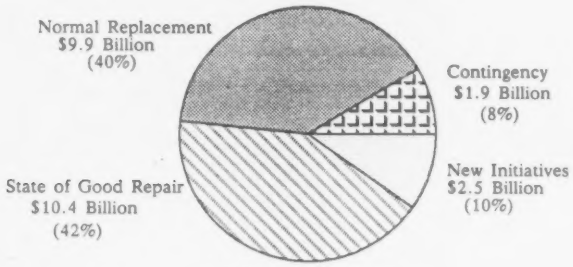
TOTAL = $31.7 BILLION

Figure 2 below shows the same classification of needs for the Transit Authority and the commuter railroads. The distribution of needs reflects the relative priorities of the transit system compared with the railroads. The Transit Authority must spend a much greater proportion of its total capital program to bring its components into a state of good repair, while the railroads need a greater proportion of their programs for life-cycle replacement of components that have already been brought into good repair and to provide additional capacity and accommodate their forecasted increases in ridership.

FIGURE 2
AGENCY CAPITAL NEEDS BY NEEDS CATEGORY (1987–2006)

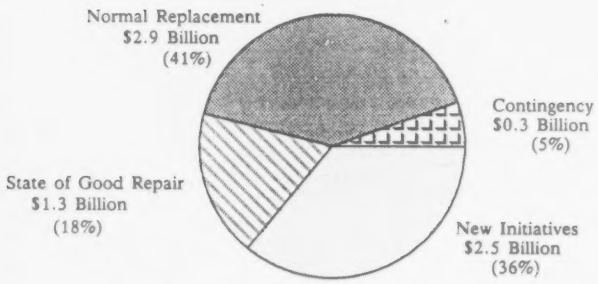
(1986 Dollars)

TRANSIT AUTHORITY



TOTAL = $ 24.7 Billion

COMMUTER RAILROADS



TOTAL = $7.0 Billion

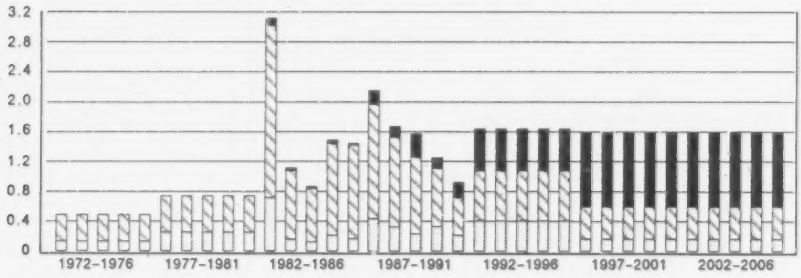
Figure 3 below breaks out the 20-year needs over time, projecting the amounts required in each year on state of good repair, normal replacement, and new initiatives projects. The charts also compare the future needs with the historical levels in the 1982-86 program, as well as with the pre-1982 levels. The equalized annual needs for the 1992-2006 period are $1.6 billion (approximately $1.2 billion for the Transit Authority and $0.4 billion for the commuter railroads).

Figure 3

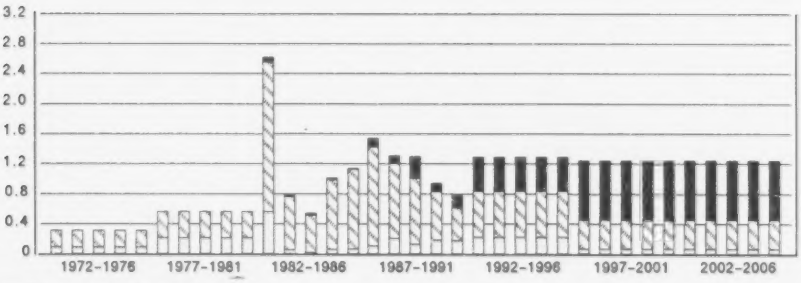
PAST INVESTMENT AND FUTURE NEEDS

1986 Dollars in Billions (Post 1991 needs at equal annual levels)

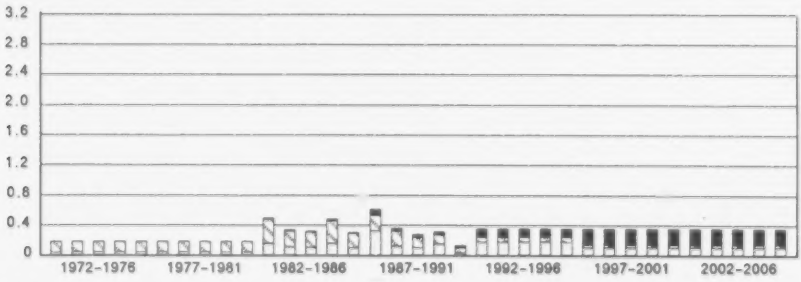
MTA



TA



COMMUTER RAILROADS



New Initiatives State of Good Repair Normal Replacement

82-549 0 - 88 - 3

In general, the agencies will invest a greater proportion of their resources in the earlier years in bringing their plants into a state of good repair. In the later years, the state-of-good-repair work will gradually give way to a program of normal replacement. In the 1997-2006 period, the bulk of the railroads' programs will consist of the normal replacement of the electric-car fleets that were purchased in the late 1960s and early 1970s. Only 16% of the MTA's projected capital needs for the next 20 years will consist of new initiatives -- that is, projects that seek to expand service substantially or to improve its quality and efficiency beyond the limitations imposed by the existing plant and equipment.

FINANCING TRANSIT NEEDS

Turning to the issue of how the MTA's needs and those of other transit systems might be met through federal programs to encourage infrastructure investment, I would like to provide some ideas based on the MTA's experience with the rebuilding of its transit system.

There are certain principles underlying the programmatic suggestions that I will make, and I would like to outline those principles:

First, there is no question that the federal government should share in programs to restore and expand investment in public facilities. These public facilities are necessary to the strength of our economy and the quality of our life. If there is any doubt on this matter, it should be dispelled by recent economic research such as that by the Federal Reserve Bank of Chicago (attached) showing the strong correlation between public investment and private-sector economic growth. If the federal government wants to achieve the degree of economic growth necessary to sustain our standard of living, it must assure, by whatever means are appropriate, the existence of basic facilities that will support such growth. The resulting expansion of net taxable income in the private sector becomes the basis for expanded revenues from current tax rates that should be more than sufficient to finance the public investment.

Second, the definition of infrastructure in any federal program must be broad enough to encompass facilities of particular importance in any local area. Specifically, public transit facilities must be included for any program to be meaningful in this region. A well-designed program should, in fact, function to meet the diverse needs of particular areas, whether they are New York's need for transit or the need for freeways or augmented water supply in the Southwest. While specific federal investment programs exist in these functional

areas and should be continued, they tend to meet average need levels, not the special needs that support the unique nature of diverse regions.

Third, any program must encompass infrastructure rebuilding as well as new investment. Rebuilding existing support systems, such as New York's transit infrastructure, is essential to preserving all of the major public investments -- water, sewer systems, schools, etc. -- that have grown up around transit-related development over many decades. Taking advantage of these built-in investments is far preferable to starting fresh with all the needs in new areas, and a continuing programmed maintenance approach is cheaper than replacement with new equipment.

Fourth, the program's design should put a major emphasis on encouraging local investment as a serious measure of local commitment to projects and, in return, should minimize the imposition of federal burdens that are too often the price of national assistance. If there is a real federal concern for investment in infrastructure, it is important that it be weighed appropriately -- and heavily -- against desirable, but less central, goals that are often enforced with mandates to achieve social/environmental/economic ends or to deter other actions such as the imposition of locally determined tolls, etc. In this regard, I note the great success of the now defunct

safe-harbor leasing program for transit vehicles, which extended by 25% the MTA's ability to buy new subway cars without any need for any federal bureaucracy and with a clear record of rewarding local investment that was being put in place. We are not asking for the sort of "ten cents on the dollar" federal funds that generate projects regardless of real needs.

Fifth, existing federal programs and levels of support should be regarded as the foundation for meeting the infrastructure needs of the nation. While these programs of public works assistance for transit, highways, water, sewers, and the like can and should be improved upon, I do not believe that they should be supplanted by an infrastructure plan at this time. Rather, an infrastructure program should be the basis for accelerating progress and targeting federal help to areas not readily reached by the basic forms of aid.

Within these basic principles there are many ways that federal help for transit infrastructure can be provided as an effective supplement to the existing Urban Mass Transportation Assistance program.

Local Investment

The federal government could encourage local investment for transit needs simply by ceasing its continual efforts to kill the use of municipal debt as a means of infrastructure finance.

I use such a harsh description because I think nothing short of that really captures the impact that the last half-decade of "tax reform" has had on agencies such as the MTA.

Our capital program is predominantly self-financed, with nearly two-thirds of its capital coming from non-federal sources. As part of our program, we contemplate a total of about $6 billion in tax-exempt debt over a ten-year period. But each time federal tax legislation has been enacted -- or even considered, threatened, or rumored -- our ability to provide local funding has been challenged and weakened, or at least burdened with higher interest costs. The closing of the municipal markets in early 1986 was a clear message that unfortunately was heard only dimly in Washington. If you want local agencies to be participants in meeting capital needs, you must allow them the ability to use financing tools appropriate to those needs. While federal policy as expressed by the Department of Transportation and the Urban Mass Transportation Administration has stressed private-sector participation in our efforts, federal tax policy has discouraged such initiatives.

Tax-Exempt Financing

While it would be desirable for the issue of tax-exempt financing to be determined as a Constitutional matter, such an outcome is not likely in the near future. Pending such action, Congress -- and especially those in Congress who are concerned

with the hard issues of infrastructure decay rather than the debatable issues of tax policy -- should review the cumulative impact these tax measures have imposed. For example, the "arbitrage" restrictions placed upon our debt issues have had a direct impact on our ability to be self-sufficient. Our previous ability to borrow in the tax-exempt markets and invest in the taxable markets traditionally provided a substantial additional revenue source to help self-fund our capital program. The current lack of availability to benefit from this positive arbitrage translates into a need to raise larger amounts of debt to accomplish the same results.

Debt Refunding

By the same token, limiting our ability to refund our debt and reduce our debt-service costs makes absolutely no sense. The Treasury is the direct beneficiary of the proceeds when we purchase below-market Treasury debt, so called SLGS. By limiting its own market for SLGS, the Treasury must issue larger amounts of open-market securities to fill the gap. Larger Treasury offerings mean higher interest rates paid on those securities, which are normally issued at rates higher than the SLGS to begin with.

Senseless and self-defeating issues such as these -- and there have been many others -- seldom rise to the top of the tax-reform debates, but taken together they are eroding our ability to meet our share of our capital needs.

Beyond this hope that we might be left alone in future tax bills, insofar as possible, an infrastructure program could provide positive enhancements to our self-help efforts.

Low-Cost Loans

Some suggested legislation in this area has focused on low-cost loans as a means of supporting local initiatives. Such an approach could have significant effects for the MTA.

In the current five-year capital program, covering 1987-91, we plan about $3.2 billion of debt financing from revenue sources that might otherwise be available to meet our operating needs -- such as Triborough Bridge and Tunnel Authority tolls, transit fares, and special regional taxes. At present, we estimate the gross annual cost of this debt, once fully issued, at about $265 million per year. This assumes current market conditions, under which bonds would carry interest rates of 8.2% to 8.5% based on their various credit ratings. A federal program that would lower this cost to, say, 3% a year interest would save us about $100 million a year, the equivalent of 7% in fare increases that would otherwise be needed to maintain a balanced operating budget.

Such reduced-rate loans could come from federal revolving funds, with the difference between interest payments and federal government costs provided as a subsidy to the revolving

fund. Alternatively, the subsidy could be provided directly to the local agency as an offset to its market-determined borrowing costs, with the possibility of using taxable bonds in this case as a means of reducing the net impact on the U.S. Treasury.

Loan Guarantees

Lesser, but still meaningful, support to local financing could come from federal programs to provide loan guarantees or insurance as a means to enhance local creditworthiness and reduce borrowing costs. For example, in today's market, an MTA farebox bond would carry an interest rate of 8 3/4%. Bond insurance could lower that to 8 1/2%, and a federal guarantee might bring it down even further, if appropriate action were taken to retain tax exemption for such guaranteed debt.

Direct appropriations to provide the cost of insurance, or transfer of funds now appropriated but for various reasons not used in the categorical grant programs, could provide a basis for bringing the program "on budget," if appropriate.

Loan guarantees, in the alternative, would have no explicit impact on the federal budget, although it is conceded by most students of public finance that their cost is passed on through their impact on overall interest costs in a market that has increased demand for borrowed funds.

Other devices, including the more flexible use of existing infrastructure grants through multi-year contracting arrangements and advance construction financing, could also be helpful, especially in regions where major one-time needs have to be met and there will be cost savings through more efficient project packaging and contracting.

All of these methods I have described are means of rewarding local effort, not just stimulating public works through the availability of cheap federal money. I believe that New York's transit program in recent years is a good example of the kind of investment that can be made to restore infrastructure and enhance the local economy. I look forward to working with your committee on means whereby the federal government can be an even more effective partner in our effort. The effort will cost federal dollars -- whatever form they take -- but will also pay major dividends in future years from a renewed economic base.

NATIONAL NEEDS: APTA'S TRANSIT 2000 TASK FORCE

The federal role in public transportation expanded exponentially for 20 years until 1981, when it came to a near halt. Seven years later, in 1988, public transportation has reached a critical juncture. Although those of us who run transit systems and understand how essential they are to the regions they serve are comforted by the authorization in 1987 of a strong mass transit program through fiscal 1991, we are well aware that 1988 brings an uncommon responsibility and an unprecedented opportunity to shape the transportation agenda well past the turn of the century.

APTA, the American Public Transit Association, has monitored closely the harm done by long-term disinvestment and underinvestment in transportation infrastructure. As a consequence, this national association of transit providers and those industries and interests allied with them is in a unique position to create a vision, then a strategy and program that will enable public transportation to reverse the damage and to achieve its long-term potential as a mainstay of the nation's economy and an important contributor to its environmental well-being.

APTA has formed a Task Force on Public Transit for the 21st Century, called Transit 2000, which I am privileged to chair. This relatively small group is engaged in examining and

articulating the problems and promise of our industry for the years well beyond the expiration of the current mass transit authorization.

The task force's committees are examining how trends in demographics, energy use, and the economy may affect the future of transit. We are considering such questions as how public transit can best provide services to urban areas that are growing once again and to suburban areas whose highways are suffering from the gridlock once confined to the cities, now that the era of massive highway construction has ended. We are looking at potential sources of funding for transit services, at the promises of new technologies for moving people, at possible forms of transit management and governance, and at the various means to articulate transportation's long-term capital needs to the public.

The premise underlying these studies is that good mass transit is not an end in itself, but that it brings our nation a host of economic and social benefits. As a corollary, the greatest benefits can be realized only if ridership is made to increase. Capital expenditures to rebuild transit infrastructure should be undertaken not merely to provide reliable, clean, safe service. They have a much broader goal: to offer service that goes where and when customers need it, service that is an appealing alternative to the private

automobile, encouraging people to choose transit, rather than their cars, in ever-increasing numbers.

At the same time as we must invest directly in the provision of responsive transportation services, complementary actions have to be taken by other entities in our economy, entities over which we exercise no control. Developers, bankers, employers, labor, state and local government bodies -- all have a role to play in the use and renewal of infrastructure and the establishment of priorities for rebuilding and expanding highways, water delivery systems, mass transit, and the like.

In our explorations of mass-transit's future, Transit 2000 is forging a vision of an industry that no doubt will become something quite different from what it is today, for it is evident that merely rebuilding what exists is not enough. In New York over the past ten years, for example, we have been rebuilding systems that were created at the end of the last century, and our hallmark has been, "Nothing new on the agenda," because that is all we can reasonably afford to do. Yet as the numbers of automobiles entering Manhattan's central business district mount each day, we know that we cannot sustain such a position indefinitely. If our goal is to change the mode of mobility in our region, we must offer public transportation to people as a practical, attractive,

economical, and environmentally desirable choice for getting where they want to go.

The current administration has forced America's transit operators to focus predominantly on microeconomic, short-term cost-effectiveness in service planning and operations, and that has been useful. But Transit 2000 manifests our awareness of the need to be wary of myopia and to forge a broader perspective, building long-term capacity and differentiating our products, just as business has done over the past half-decade. And just as business has formed many partnerships with government, healthy transit requires a continued strong federal role in financing and a broadened responsibility on the part of states and localities in what has become and should remain a partnership.

We look forward in the coming months to providing you and your colleagues with the conclusions and recommendations of our Transit 2000 task force.

In closing, I want to thank the committee for its continuing support of public transportation and for its consideration of the views of the Metropolitan Transportation Authority. We would be pleased to provide members or staff with answers to any questions you may have.

ESSAYS ON ISSUES | THE FEDERAL RESERVE BANK OF CHICAGO | OCTOBER 1987 NUMBER 2

Chicago Fed Letter

Is the public capital stock too low?

In the *Wealth of Nations*, Adam Smith argues that one of the basic responsibilities of the "sovereign or commonwealth" is to provide an adequate structure of public works to "facilitate the commerce of society." An extensive and well maintained system of roads, bridges, highways, lighthouses, and canals is necessary to meet the needs of a vital, growing economy. The duty of constructing such public works falls to the government because their benefits accrue not just to particular individuals but to the economy at large, or because the cost reductions derived from economies of scale are best captured by direct, centralized, public capital outlays.

This essay argues that current public capital expenditures are too low. The argument begins by examining recent trends in public expenditures, particularly public spending on the infrastructure of the economy, such as roads, sewers, bridges, and the like. It then shows that public sector investment ultimately increases the private capital stock by influencing the rate of return to private investment. Thus, public capital expenditures are a critical determinant of the nation's long-run production potential.

Public expenditure trends

The accompanying table presents data on United States government spending at the federal, state, and local levels during the period from 1953 to 1984. The first column indicates that total public expenditure has trended upward over this period. Government sector expenditures rose from 26.1 percent of gross national product during 1953-59 to 33.9 percent during 1980-84. In 1982 dollars, public sector spending grew from $507 billion in 1953 to $1,174 billion in 1984. Despite the Gramm-Rudman Act and attempts to slash public sector budget deficits on the expenditure side, the rising pattern of government spending continues in the 1980s.

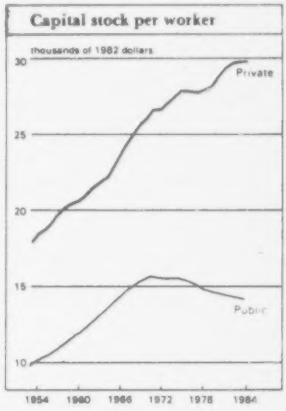
The second column shows the share of total output devoted to expanding the nation's nonmilitary public capital stock. Net public capital formation—the level of investment in roads, bridges, and so forth, after accounting for physical depreciation—tumbled from a high of 2.3 percent of GNP in the latter half of the 1960s to only 0.4 percent during 1980-84. In terms of constant 1982 dollars, public net investment was $11.5 billion in 1984, down from $27.6 billion in 1953 and $62.8 billion in 1964.

Public expenditure and the return to private capital

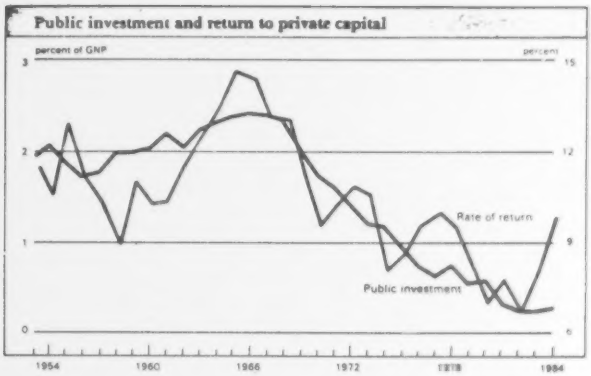
	Total government expenditure (% of GNP)	Public net investment (% of GNP)	Profit rate (%)
1953-59	26.1	1.9	10.8
1960-64	27.6	2.2	11.6
1965-69	29.1	2.3	13.3
1970-74	31.2	1.4	9.8
1975-79	32.1	0.7	9.1
1980-84	33.9	0.4	7.9

Sources: *National Income and Product Accounts*, U.S. Department of Commerce and *Flow of Funds*, Federal Reserve System.

Capital stock per worker



The graph illustrates the different behavior of the private as opposed to the public capital stock during the last three decades. During the earlier period, 1953-71, both the private and public net investment rates exceeded the growth rate of the work force, producing rising private and public capital stocks per worker. However, since 1971 net public investment has lagged behind growth in the labor force and the amount of public capital per worker has contracted from $15,576 in 1971 to $14,224 in 1984. During the same period, the private capital stock per worker has expanded from $26,654 to $29,905. A dynamic, competitive world dictates that those with influence on the nation's economic destiny be forward looking and prepare for the future in the present. Hence, it is now imperative to reassess our public investment policy.



Public investment, private investment, and the rate of return

Changes in public investment can have significant impact on private investment. For the period from 1953 to 1984, net private investment in equipment and structures averaged 3.1 percent of GNP while net public nonmilitary investment averaged 1.5 percent. During this time private and public investment exhibited nearly the same amount of volatility. Net private investment ranged from a high of 4.6 percent of GNP in 1966 to a low of 1.3 percent in 1983, while public investment hit a maximum, 2.4 percent, in 1966 and a minimum, only 0.3 percent, in 1982.

We can think of the impact of public capital accumulation on private investment as falling into two broad categories of effects, depending on whether the public investment "crowds out" or "crowds in" private investment.

Crowding out?

Higher levels of capital accumulation by the public sector arguably crowd out a substantial amount of private investment for several reasons. To the extent that publicly provided capital serves as a substitute for private capital in private production technologies, firms require less private capital to produce the same level of output. In addition, higher public sector demand in the capital goods producing sector raises the price of capital goods, thereby lowering the quantity of goods demanded by the private sector. Finally, the increased government demand creates a general scarcity of current resources, a rise in real interest rates, and a further contraction of capital spending.

In recent empirical work, I find that, holding fixed the rate of return to private capital, an increase in public investment expenditure of $1 billion crowds out anywhere from $1 to $1.5 billion of private investment expenditure.[1] The crowding out appears to occur without the assistance of changes in the cost of capital. That is, firm managers appear to take directly into account the availability of public capital for use in private production.

This result indicates that the level of the public capital stock in the United States indeed may be too low. An efficient level of public capital is attained when the addition of an extra unit of either private or public capital has the same impact on the nation's output. If the aggregate response of private firms to an expansion of public capital is to reduce private capital spending on a greater than one-to-one basis—and my empirical results suggest that this is presently the case—the marginal product of public capital may very well exceed that of private capital in private technologies. Further public capital accumulation is then required to drive down its productivity, on the margin, to equal that of private capital.

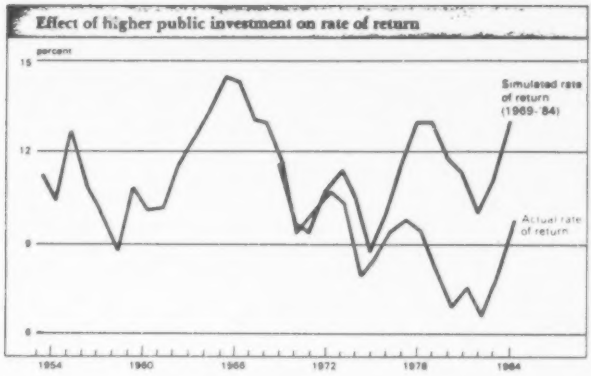
Or crowding in?

The above argument is based on an unchanged rate of return to private capital in the face of higher public capital accumulation. However, public capital devoted to infrastructure purposes is complementary to private capital in the production of goods and services. This implies that a rise in the public capital stock makes private capital more productive. New highways allow faster transportation of goods from factory to market; modern power plants cheapen energy and lower the cost of running machinery. Thus, higher levels of public investment filter into elevated profit rates for the nation's businesses.

The third column of the table contains annual averages of the net profit rate of nonfinancial corporations in the United States.[2] In a competitive marketplace, the net profit rate approximates the marginal productivity of private, nonfinancial corporate capital. As the table and graph illustrate, there is a striking tendency for the economy's rate of profit—the private rate of return on invested capital—to be high when the level of public capital formation is high over the course of several years. In particular, the decade of the 1960s reveals the highest returns on the private sector capital stock as well as the highest rates of public sector capital accumulation.

The disturbing feature of the table, of course, is the evidence from the 1970s and early 1980s. The public investment rate during this time dwindled to less than 1 percent of GNP and the rate of return to private capital shrank to 8.9 percent, more than one and one half percentage points below its post Korean War average of 10.8 percent and three and one half percentage points below the average value of 12.5 percent for the 1960s.

I am not suggesting that deficient public capital formation alone is responsible for the recent low rate of return to the nation's private capital stock and sluggish total investment. Low levels of capacity utilization in the economy's factories, mines, and utilities brought on by oil price increases and real ex-



change rate appreciation helped diminish the net profits obtained per unit of capital. However, statistical analysis indicates that the level of public capital strongly influences the net return to private capital even after accounting for such cyclical effects. The empirical results show that a 10 percent increase in the capacity utilization rate from its 1984 value of 74 percent would have raised the profit rate from 9.9 to 11.4 percent. But, in the same analysis, a 10 percent increase in the public capital stock (five years of extra net public investment of $32.4 billion, or an extra 0.9 percent of GNP) would have increased the rate of return by a still larger amount to 12.6 percent.

What would have been the effect on the rate of return to capital of maintaining a constant level of public investment of 2.1 percent of GNP—its 1953-to-1969 average—throughout the 1970s and early 1980s? The result of this experiment is depicted in the graph above. Evidently, holding public capital accumulation at this level would have eliminated the downward trend in the rate of return to private capital, although the substantial fluctuations resulting from changed currency valuations and capacity utilization still would have remained.

The likely net effect

Given these conflicting influences, what appears to be the overall impact of public investment on private investment? The available estimates imply that a temporary surge of public investment of 1 percent of GNP ($34.9 billion in 1984) would first depress private investment by 1.2 percent of GNP ($41.9 billion). However, as the rate of return to private capital increases with the higher public investment, expenditures on private plant and equipment would be stimulated, ultimately inducing a cumulative rise in the private capital stock of roughly $39 billion over its 1984 level of $3,442.8 billion. The rate of return to private capital would rise from 9.9 percent to 11 percent and gradually fall back to its original level. The national (private plus public) capital stock would have risen from $5063.6 billion to $5137.6 billion, a rise of 1.5 percent. Thus, the net effect of temporarily increasing the public investment rate is a substantial increase in the national capital stock. Clearly, public investment policy has important consequences for the economy's production possibilities.

Taking stock

The public capital stock appears to be too low relative to the private capital stock, thereby depressing the rate of profit to the nation's stock of plant and equipment. Large public sector deficits of recent years have brought attention to the overall scale of government activity. Some argue that the government should spend less and others that it should tax more. Both of these responses to the problems posed by federal budget deficit are reasonable. However, the evidence discussed here suggests that more attention should be paid to the composition of the government's expenditure, and particularly its effects on the nation's infrastructure needs. While total spending mounts, investment in public works slides. Indeed, the share of total public expenditure dedicated to net public capital formation declined from 8 percent in the 1960-64 period to a meager 1.2 percent between 1980 and 1984. By reorienting our public spending to upgrade and expand the public capital stock, we can heighten the productivity of our workforce and improve the competitive position of the United States in the increasingly open international marketplace.

David Alan Aschauer

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[1] These estimates are contained in David Alan Aschauer, "Net Private Investment and Public Expenditure in the United States 1953-84," Staff Memoranda, Federal Reserve Bank of Chicago, in press.

[2] The rate of return to capital is measured as inflation-adjusted corporate income after depreciation plus net interest payments (as a return to debt claims on firms) relative to the current replacement value of the nonfinancial sector's stock of fixed capital, land, and inventories.

Karl A. Scheld, Senior Vice President and Director of Research; David R. Allardice, Vice President and Assistant Director of Research; Edward G. Nash, Editor.

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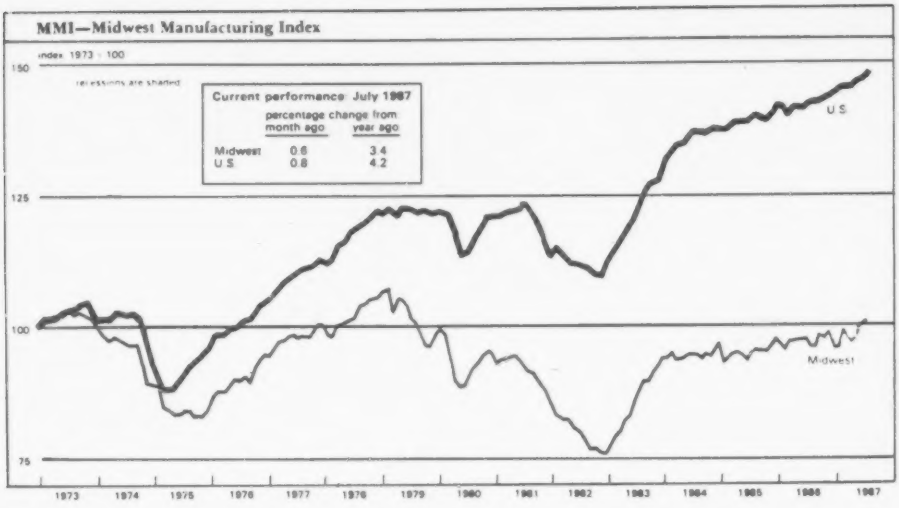

Manufacturing activity in the Midwest (defined here as comprising Illinois, Indiana, Iowa, Michigan, and Wisconsin) rose 0.6 percent in July, following an upwardly revised jump of 3.6 percent in June. The July gains were heavily concentrated in the primary metals industry, but modest improvements were also recorded in other major industries in the Midwest, notably fabricated metals, nonelectrical machinery, and electrical equipment.

Manufacturing activity in the nation (as measured by the Federal Reserve Board's Index of Industrial Production) slightly outpaced the Midwest both in July and year-over-year (see above table). However, in the last two months the MMI has moved to its highest level since September 1979.

NOTE: The MMI is a composite index of 15 manufacturing industries and is constructed from a weighted combination of monthly hours worked, and kilowatt hours data. See "Midwest Manufacturing Index: The Chicago Fed's new regional economic indicator," *Economic Perspectives*, Federal Reserve Bank of Chicago, Vol. XI, No. 5, September/October, 1987. The United States represents the Federal Reserve Board's Index of Industrial Production, Manufacturing

Chicago Fed Letter

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STATEMENT BY LOUIS J. GAMBACCINI
ASSISTANT EXECUTIVE DIRECTOR/TRANS-HUDSON
PORT AUTHORITY OF NEW YORK & NEW JERSEY
BEFORE
THE SUBCOMMITTEE ON WATER RESOURCES, TRANSPORTATION & INFRASTRUCTURE
UNITED STATES SENATE
JANUARY 21, 1988
ONE FEDERAL PLAZA

Thank you for this opportunity to share our views on the transportation infrastructure needs of this metropolitan region. Today's hearing is most timely, as our region -- and transportation professionals across the country -- are just now shifting our sights from the problems of coping with the recent explosion in transportation demand to focus on the needs of the Nineties and beyond.

In most metropolitan areas, this one included, there is no single standing mechanism to facilitate a comprehensive, regional transportation needs assessment. However, across the country, heads of transit and highway agencies, local and state transportation agencies, and business community leaders have been addressing this subject with increasing urgency. These local efforts are mirrored in the Transportation "2020" program led by AASHTO, a similar initiative by the American Public Transit Association, and the work of the Transportation Research Board, of which I have just become Vice Chairman.

These forums have in common a recognition that burgeoning demand in the nation's growing metropolitan areas is the central transportation planning challenge facing America in the years ahead. This is a national priority, not just a local concern, because our metropolitan regions have become the economic engines of the nation. In a competitive world economy, the nation's strength is largely dependent on the efficient working of metropolitan areas that are national and regional centers of trade and commerce, finance, transportation, and communications. Efficient movement of people and goods in these emerging metropolitan districts is the vital underpinning of their economic life.

Today I want to touch briefly on the status of this region's transportation network and our prospects for meeting projected growth in demand for regional mobility. The federal government has a critical role to play in supporting efforts here and elsewhere to shape and implement areawide mobility strategies. Without this kind of strategic thinking, this region and others simply cannot fulfill their potential for future growth and economic expansion.

METROPOLITAN TRANSPORTATION: AN INTEGRATED SYSTEM

The key theme in addressing the metropolitan mobility challenge can be summed up in one word: integration.

- Metropolitan areas increasingly are seeing their highway and transit services as a single integrated system;

- Federal, state, and local officials want to integrate their efforts to identify the best, most cost-effective investments and innovations;

- Public and private sector leaders seek a framework for integrating their interests through expanded joint ventures;

- Business and government planners are striving to integrate economic growth with the transportation services needed to support it.

Federal policies should evolve as quickly as possible to facilitate these new directions.

THE REGIONAL OUTLOOK

In this region, economic growth has been happening everywhere at once over the past decade. The New York - New Jersey metropolitan region has gained more than one million jobs since 1977. Population growth in the region has resumed. With an improving economy, both states have been able to invest heavily in catch-up repairs to the existing highway and transit network. We have devised coping strategies to get the most out of the existing network and carry the region into the early Nineties. Overall, the region has commited more than $30 billion to transportation improvements in this decade.

For the 17-county, bi-state region we serve the long-term prospect is for further growth in population and jobs on all fronts through the end of this century. It's clear that coping strategies for transportation won't be enough to meet projected transportation demand in either the cities or suburbs.

Many other metropolitan areas across the United States are confronting the same challenges of satisfying short term needs, while trying to identify projects and funding to support further anticipated growth.

The Manhattan central business district, or CBD, remains the economic centerpiece of the region. Its concentration of jobs has reached record levels, and its employers are drawing on a widening ring of counties to meet their skilled labor demands.

During this period, transit has strengthened its role as the main transportation link for the CBD commuter market. Today, an astounding 84 percent of all CBD-bound commuters use transit. Multi-billion dollar investments by the Metropolitan Transportation Authority, New Jersey Transit, and the Port Authority have come just in time to intercept the job growth curve, and have barely kept pace with increasing demand, especially during peak commuting hours. Most transit services in the region have been visibly improving as a result of these investments, and newly released figures for 1986 finally show auto entries

to the CBD dropping as total employment and transit ridership continued to grow.

Both states have stressed the transit option for all the dispersed corridors that feed the CBD. The Port Authority, which serves the trans-Hudson market with transit and vehicular crossings, has actively supported this strategy. The Exclusive Bus Lane route effectively has turned the Lincoln Tunnel into a transit facility during rush hours. It carries as many people across the river as PATH, our transit service, which is now in the midst of a billion dollar rehabilitation and expansion program funded by the Port Authority.

That investment is part of a $5.8 billion, five-year capital program unveiled by the Port Authority a year ago. The program, the biggest construction effort undertaken in the agency's history, is focused heavily on improving the efficiency of the region's surface transportation system. Its components include, in addition to the PATH program, rehabilitation of our six interstate crossings, creation of a passenger ferry service serving the lower Manhattan market, and support for other improvements on the highway and transit network of which our facilities form one link.

Another key element of the program is a substantial commitment to improve ground circulation at our three metropolitan airports, and to work with transportation agencies in both states to improve ground access to Kennedy, Newark International Airport, and LaGuardia. Rapid growth in annual passenger totals at all three airports is straining available ground access capacity, another indicator of the transportation demands engendered by economic growth.

For the CBD market, we have had the infrastructure -- particularly the transit infrastructure -- in depth to cope through system improvements and incremental expansion of transit services. Even so, many of these links are now effectively at capacity during commuting hours, and the new projects on the drawing boards will "max out" their capacity in some cases by the early Nineties.

But that's only part of the regional story.

Most of the employment growth, and nearly all the new housing construction, in the past ten years has taken place outside the region's older core communities. The suburbs are no longer the city's "bedroom". New Jersey suburbs have put up more office space than Manhattan during this period. Barely a quarter of the work force in New York's suburbs now works in Manhattan, and a tenth of New Jersey's. In fact, we are seeing apparent growth in the numbers of Manhattanites commuting to suburban jobs.

Today and tomorrow, it is suburb to suburb commuting that is creating the worst pressure points on the region's transportation network. That reflects the national trend. In 1970, about 16 million commuters nationally went suburb to suburb. That figure reached 25 million by 1980, and the trend is continuing.

Another element of the equation is trucking. Trucks carry more than 90 percent of the region's goods. One indicator is that trucks using our six interstate crossings, measured in the eastbound (toll collection) direction alone, carried more freight tonnage than our maritime port facilities and airports combined.

Chronic traffic congestion is impeding truck deliveries, increasing costs to area businesses. Most of the region's new warehousing construction is taking place in the outlying counties, where open land is more readily available and affordable. This is lengthening our supply lines. These factors help make highway improvements, even in urban areas, an emerging regional priority.

To realize its potential for further growth, this region will need to make substantial new investments in both its CBD-oriented services and in highway expansion and transit services in the intersuburban market. This is a multi-billion dollar agenda, with only a fraction of the required funding in sight.

By way of example, New York St te now is using state and federal funds and bond issue proceeds to support a one billion dollar statewide program of pavement and bridge rehabilitation, much of it downstate. A state advisory committee estimates that by 1990, $1.7 billion in annual funding should be made available to continue rehabilitation work and undertake new system improvements. The MTA estimates its annual capital needs at $1.5 billion dollars beyond the massive capital program now on schedule for completion in a few years. A new trans-Hudson crossing of any kind, if shown to be needed, would cost more than a billion dollars, including landside connections.

Even as we plan system improvements, getting the most capacity out of the existing network is essential. Nearly 20 transportation agencies in the bi-state region recently joined to create TRANSCOM, a bi-state group working to improve daily traffic management and to coordinate other related activities. Another new group, TRANSITCENTER, brings together the region's transit operators with local business leaders to market our improved transit services for maximum use by the commuting public.

In sum, this region is building upon its already impressive transportation infrastructure to meet the challenges of a growing economy. These highways and transit lines need further rehabilitation, and selective expansion of both systems is needed to meet growing demand on many travel corridors in the region. Initiatives like TRANSCOM reflect our growing understanding that transportation providers must see their services as the public and business users see them: an integrated system that transcends political and agency and modal boundaries.

FEDERAL SUPPORT FOR METROPOLITAN MOBILITY PLANNING

Washington can better support this emerging metropolitan mobility strategy, so vital to this region and other facing similar problems across the nation. Here are some basic principles to be applied in considering the most appropriate federal role:

- Maintaining mobility is the central objective. Commuters don't have a constitutional right to drive to work and pull into a nearby employer-provided or employer-reimbursed parking space. Employers and developers can no longer plant their facilities whevever they wish and expect taxpayers to foot the entire bill for providing premium commuting and fright access service. Commuters and employers must fairly share the burden with government. We will get the level of mobility we are willing to pay for.

- An all-out attack on metropolitan traffic congestion is a national priority. Aggressive, sophisticated transportation system management approaches are needed to get the most out of the existing system until appropriate expansion of capacity can be created. Many urban areas are trying this approach now in cities and suburbs, and it should have expanded support in the range of federal transporation involvements. Our regional USEPA Administrator and the UMTA Administrator both have addressed this opportunity in public statements this month. We look forward to continued federal leadership and programmatic support to this end.

- Federal aid programs for highways, transit services, and system innovations should continue through the Nineties and beyond, but should be made available on a more flexible basis. Today's compartmentalized funding programs work against coordinated regional mobility planning and can distort the local decisionmaking process.

- Federal tax policy should provide a framework through which state and local officials can encourage private investments to improve metropolitan transportation systems. We strongly support public interest efforts to reinstitute safe-harbor leasing and to restrain proposals which inhibit certain tax-exempt bond financing, such as those originally passed in the recent house tax bill (H.R. 3545). Congress also should redress the present imbalance of federal tax treatment for employer transit subsidies as against fringe benefits that have the effect of encouraging auto commuting.

- The federal government should stake out clearly defined roles in transportation research and development for system repair and new technologies. These range from developing new non-invasive techniques for testing the structural integrity of tunnels to development of "mag-lev" transit. Washington should help develop and standardize innovations like electronic toll collection and multi-system transit fare collection. These innovations will make for faster and more convenient travel. They also will facilitiate shared financing for transportation services where appropriate.

- Federal efforts should support improvements in truck freight handling, where the national character of the industry impedes local initiatives. From truck routing, to truck types, to truck safety, an active federal role is essential.

Senator Moynihan, you have been a leader in identifying the national interest in maintaining America's public works infrastructure. The region you represent continues to be a leader in making its own transportation investments, and we see many problems and opportunities in common with other metropolitan areas. Creating an efficient transportation system for these growing urbanized areas is a vital part of the national effort to rebuild America's economic competitiveness. In this region, we look forward to continuing a strong partnership with the federal government in achieving this goal.

NJ TRANSIT

WRITTEN TESTIMONY OF

JEROME C. PREMO,

EXECUTIVE DIRECTOR, NJ TRANSIT

VICE CHAIRMAN, AMERICAN PUBLIC TRANSIT ASSOCIATION

BEFORE THE SUBCOMMITTEE

ON WATER RESOURCES, TRANSPORTATION, AND INFRASTRUCTURE

OF THE COMMITTEE ON ENVIRONMENT AND PUBLIC WORKS

HONORABLE DANIEL PATRICK MOYNIHAN, CHAIRMAN

JANUARY 21, 1988

McCarter Highway & Market St., P.O. Box 10009, Newark, N.J. 07101 (201) 648-7300

As Vice Chairman of the American Public Transit Association, and as Executive Director of the New Jersey Transit Corporation, I want to thank you for the opportunity to discuss the needs of public transportation and why transit needs should be addressed in an overall infrastructure bill.

NATIONAL TRANSIT INFRASTRUCTURE NEEDS

A national infrastructure funding program which includes transit is essential given the gap which exists between transit funding authorizations and projected investment requirements. In April, 1987, Congress reauthorized the federal transit program through fiscal 1991. As a result, approximately $11.7 billion in federal capital funding is estimated to be available between 1988 and 1992. However, a recent transit needs survey conducted by the American Public Transit Association (APTA) identified $31.4 billion in transit infrastructure needs for that period. The $19.7 billion gap which exists at the fully authorized level between available funding and essential transit capital needs is a conservative estimate given the current efforts at deficit-reduction, which this year resulted in transit funding 14.5 percent below the authorized level. While states, cities, and the private sector are increasingly striving to make up for this shortfall in funds, a gap of this magnitude cannot be overcome through non-federal sources. I appreciate this Committee's interest in helping to address ways to plug that gap.

FIVE-YEAR TRANSIT INVESTMENT NEEDS

APTA has recently updated a five-year mass transit capital requirements survey of transit systems around the country, which was originally conducted in 1983. The survey was intended to better inform Congress and local officials of the financial commitment required to meet local, state and national transit objectives. Highlights of the transit investment requirements for 1988-1992 identified in this survey include:

- Total capital investment requirements of $31.4 billion, 1988-1992, or an average of $6.29 billion per year;
- $10.1 billion in bus and bus facility investments, including $4.5 billion in vehicles, $3.5 billion in facilities and $2.1 billion busway and bus lane facilities;
- $12.4 billion in rail system modernization;
- $8.5 billion in new rail system development;
- $449 million in vehicle and facility needs among small urban and rural systems;
- A $19.7 billion capital shortfall when five-year investment requirements are compared to authorized funding levels;

In updating its five-year capital investment survey, APTA received responses from 140 transit systems, representing over 70 percent of the transit vehicle fleet, nationwide.

The overall results of the survey are provided in Table 1, indicating a total capital investment requirement from 1988 to 1992 of $31.4 billion.

FIVE-YEAR TRANSIT CAPITAL INVESTMENT REQUIREMENTS BY MODE (Table 1):

1988-1992

Mode	Capital Investment Required* (millions)		Percent
Bus		$ 10,104	32.2
Vehicles	$ 4,488		
Facilities	3,525		
Busways/HOV	2,091		
Rail		20,878	66.4
Modernization	12,364		
New Rail Systems and Extensions	8,514		
Small Urban/Rural		449	1.4
Vehicles	318		
Facilities	131		
		$ 31,431 M	100.0%

In addition to this $31.4 million, there are some half-dozen possible rail projects including those in Chicago, Cleveland, Columbus, Honolulu, Milwaukee, Minneapolis-St. Paul and San Jose that are under serious consideration locally which have not been included in this analysis. These projects could add as much as $2.5 billion to the new system development and extension figures included in Table 1.

* 1988 dollars

UPDATE ON THE CONDITION OF CAPITAL FACILITIES AND EQUIPMENT

Recent capital investments in transit have enabled transit managers to make some progress in improving the overall condition of plant and equipment. The progress has been slower than desired. A greater immediate commitment of resources at all levels, including the federal level, remains essential to seriously reduce the continuing capital investment backlog. Inclusion in an infrastructure program would help to reduce this funding backlog.

Updated figures on the current condition of transit plan and equipment are highlighted below:

BUS VEHICLE FLEET:

--Average fleet age is 8.4 years;

--23 percent of the fleet, (14,167 vehicles) is over 12 years old;

--12 percent of the fleet (7,181 vehicles) is over 15 years old;

--The immediate cost to replace vehicles over 12 years old exceeds $2.1 billion.

RAIL VEHICLE FLEET:

--Of over 10,300 heavy rail vehicles:

- the average age is 17 years;
- 21.4% (2,200 vehicles) are over 25 years old;
- immediate replacement of those over 25 years would cost in excess of $2.2 billion;

--Of nearly 940 light rail vehicles:

- the average age is 16 years;
- 37.6% (351 vehicles) are over 25 years old;
- immediate replacement of those over 25 years would cost in excess of $440 million;

--of 4,150 commuter rail vehicles:

- the average age is 15.4 years;
- 19.5% (810 vehicles) are over 25 years old;

- immediate replacement of those over 25 years old would cost in excess of $600 million.

BUS FACILITIES:

--Of the 325 bus facilities identified:

- 16% are over 60 years of age;
- 23% are over 40 years of age;
- 33% have capacity shortages under current service conditions.

RAIL FACILITIES

--Of 138 rail maintenance and operating facilities identified:

- 38% are over 60 years of age;
- 64% are over 40 years of age.

It is clear from the current condition of transit plant and equipment that a very substantial portion of total capital needs throughout the industry are associated with equipment and facilities that have already reached or exceeded their economic life.

The objectives of improving efficiency and productivity, reducing operating costs, and increasing the quality and reliability of service cannot be fully met if this capital investment backlog is not significantly reduced.

NEEDS ASSOCIATED WITH CURRENT LEVELS OF SERVICE

Over 70 percent of the infrastructure needs for 1988-1992 are necessary to maintain current transportation services and meet existing demand. Over 72 percent of the reported bus needs in the next five years are directly associated with maintaining current levels of service. Modernization of existing rail systems and services represents nearly 60 percent of all rail needs.

Attached is a list of areas reporting rail or fixed guideway needs in the years 1988-1992. As you can see, both rail modernization and new system needs are extensive and nation-wide, reaching all regions of the country. The extent to which these needs can be met will determine the effectiveness of our nations transit infrastructure for years to come.

NEW YORK/NEW JERSEY REGIONAL NEEDS

Before turning to funding solutions, I would like to bring this

discussion closer to home by focusing on the New York/New Jersey region. Mr. Kiley is discussing the MTA's capital program, which will total more than $16 billion between 1982 and 1991. I will now discuss what we in New Jersey have done with our transit infrastructure and what our future needs are.

Since 1980, NJ TRANSIT has purchased and approximately 1,200 buses, reducing the average fleet age to between 8 and 9 years. Additional bus procurements now under way will reduce the average age to approximately 6 years. NJ TRANSIT has also purchased $119.5 million in rolling stock for private bus carriers throughout the State of New Jersey. By August, 1988, we will have replaced or rehabilitated 627 rail cars and 63 locomotives, adding hundreds of essential seats to our rail system.

A total of $67.5 million has been invested in the modernization of bus facilities, including the construction of new facilities in Howell and Washington Townships. Major rehabilitation of three garages is underway, and we are in design stages at six other garages.

In July, 1987, NJ TRANSIT opened the Meadows Maintenance Complex, a state-of-the-art rail equipment maintenance facility. Almost $77 million has been invested in rehabilitated rail stations and platforms. In all, over 100 rail stations have been rehabilitated for passenger comfort and safety.

Between 1979 and 1987 NJ TRANSIT committed $1.5 billion to restoring and reversing years of deferred maintenance. While we have done much to rebuild the public transit infrastructure in New Jersey, more remains to be done. It is anticipated that $850 million will be needed between 1989 and 1993 to simply maintain the existing system. This basic investment does not address the trans-Hudson crossing congestion which threatens to slow the growth of the overall region.

Almost 135,000 passengers crossed the Hudson each morning and evening in 1983 on public transportation to their jobs in this city. They share the crossings with 63,000 automobiles. While only 10 percent of Manhattan jobs were held by New Jersey residents in 1980, one out of three new Manhattan jobs is now held by a trans-Hudson commuter. NJ TRANSIT expects an additional 58,000 trips across the Hudson by 1995. It is essential that our transit system be able to accommodate these passengers to prevent trans-Hudson auto traffic from coming to a standstill.

NJ TRANSIT's "Transit Plan for the 1990's," released last June, identifies the infrastructure improvements needed to bring our transit system to the service level necessary to serve the growing commuting population and attract additional riders out of their cars. The plan includes,

- A bus-only lane along the New Jersey Waterfront from the

New Jersey Turnpike to the Lincoln Tunnel and later across the Meadowlands through the Bergen Arches in Jersey City.

- o A North Hudson busway as part of the Waterfront transit system.
- o The dedication of the Weehawken Tunnel for buses and light-rail vehicles to the Waterfront and Lincoln Tunnel.
- o A Secaucus Transfer station to give passengers from Northern New Jersey and Orange and Rockland Counties in New York convenient rail service into midtown Manhattan.
- o The restoration of the West Shore Rail Line to bring rail service into eastern Bergen and Rockland Counties.
- o The Kearny and Montclair Connections, providing direct midtown Manhattan service to residents of central New Jersey.
- o Additional improvements to eliminate rail delays and provide additional parking and seating capacity on rail lines with growing ridership.

Besides meeting trans-Hudson commutation needs, New Jersey must also address public transit needs in the southern part of the state and the growing suburban areas across New Jersey.

In Southern New Jersey NJ TRANSIT has undertaken an extensive planning study which will analyze the demographic, travel markets and public attitudes towards transit. On the basis of this analysis NJ TRANSIT will propose transit service opportunities which strengthen the existing transit system through operational and capital improvements and expand the transit system in areas where the demand supports such expansion.

NJ TRANSIT is also exploring ways to meet the growing demands for transit alternatives in suburban New Jersey, where skyrocketing economic development is choking the highways. This exploration will eventually result in a plan for addressing suburban travel needs which may incorporate non-traditional service alternatives and funding strategies. Overall, NJ TRANSIT will be committing $1.5 billion between 1989 and 1993 to the maintenance, improvement, and expansion of our state's transit system.

FUNDING PARTNERSHIP

As you can see, the need to provide adequate funding for national and regional transit investments is critical. The overall $31 billion national need cannot be met through existing federal, state-local commitments. We need to collectively address this issue of funding,

or the improvements that transit has achieved since the late 1970's, in terms of ridership and the elimination of deferred maintenance will be reversed.

We in New Jersey are taking the necessary steps to ensure adequate transit funding through the renewal of our Transportation Trust Fund. To date, the Trust Fund has provided state funding totalling $773 million for highway projects and $200 million for transit infrastructure between 1985 and 1987. The Transportation Trust Fund was financed in part through 2 1/2¢ of New Jersey's gasoline tax, which is used to repay bonds issued by the Trust Fund. In addition, $88 million was appropriated annually by the State Legislature, $25 million annually was contributed by independent toll road authorities, and $30 million annually was generated through an increase in heavy truck registration fees. The dedication of this funding enabled the state to draw down almost $2 billion in federal funding, for a total transportation program of $2.9 billion including a transit capital program of $737 million.

The Transportation Trust Fund has recently been renewed for another seven years through the dedication of an additional 2 1/2¢ state gasoline tax. The Trust Fund is intended to be a long-term approach to state investment in public transportation. The goal is for the Fund's bonding cycle to be completed every 12-17 years, with new bonds being issued as the old ones are retired. This will provide a stable capital funding source for New Jersey's transportation needs well into the twenty-first century.

While I am here today to talk about transit funding needs and sources, there is another example of an infrastructure funding mechanism in New Jersey which I think is worthy of discussion.

In 1985, the New Jersey State Legislature created the New Jersey Environmental Trust, funded through a combination of state bonds and general funds. One element of this Trust Fund is the Wastewater Treatment Trust, which works as a revolving loan fund. Financed through a $190 million bond issue approved by New Jersey voters, the Trust is a state finance authority empowered to issue revenue bonds, to make loans to local government, and to guarantee debt incurred by local government for the construction of wastewater treatment projects. Forty million of the $190 million is to be held in a reserve fund against which the trust may borrow. The funds borrowed against this reserve and against the loan repayments which will come in from local government will be lent to local governments at substantially below the market rate. The other $150 million will be lent to local governments interest-free, or at very low interest, through a revolving loan account.

This revolving loan concept works in New Jersey, and could be

considered as you discuss a National Infrastructure Funding Bank.

As you consider various funding mechanisms, keep in mind that public transit is a deficit operation. In setting up an infrastructure program, the Subcommittee may want to explore ways to coordinate an Infrastructure Bank with existing federal funding, programs, particularly the Urban Mass Transit Program. For example, public transit agencies could be permitted to borrow from the Infrastructure Bank for up front expenses of federally funded projects which would later be repaid through UMTA grants. This would enable transit agencies to leverage federal dollars and complete projects earlier than currently possible, buying more for their federal dollars.

CONCLUSION

Including public transit in a federal infrastructure program is essential for three reasons:

1. Current needs exceed current funding levels by almost $20 billion over the 1988 to 1992 period. The longer we postpone filling those needs, the more expensive it will become to do so. An infrastructure loan program would go a long way toward closing that gap.

2. The viability of public transit is essential for promoting the economic development of our nation's urban areas. A recent study by the National League of Cities, entitled The Visible Hand revealed that more than four out of five communities anticipated negative effects on economic development in their communities as a result of cuts in community development programs, tax-exempt revenue bonds, and highway and transit funds. While an infrastructure program does not stop Congress from further reducing essential federal support for transit, it does provide a funding mechanism through which needed monies can be channelled.

3. Today's reality of budget cuts and the erosion of federal transit spending have prompted states and local governments to spend more in an attempt to fill the funding gap. The American Association of State Highway and Transportation Officials' recently released "Survey of State Involvement in Public Transportation" reveals that in 1987 the total state funding for public transportation had surpassed federal funding for the first time. An infrastructure Funding Bank would enable states to leverage money they are already spending and buy more with their state transit dollars.

In conclusion, as total public transit spending as a percentage of gross national product has declined by nearly 20 percent since 1980, we must work together to keep our transit systems on the right track.

Transit agencies cannot look solely to the federal government for their funding. The transit industry is not doing that. That is why, as you have heard, we are vigorously exploring and developing options for meeting the public transit needs to the year 2000 and beyond. One thing is clear: the federal government must continue to invest in infrastructure. Public transit is one element of that investment. I appreciate this Subcommittee's interest in the needs of transit. On behalf of APTA I extend our full cooperation to assist you in yo r effort to develop a funding mechanism to meet our nation's infrastructure needs as we approach the twenty-first century.

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AREAS REPORTING RAIL OR FIXED GUIDEWAY NEEDS: 1988-1992

Mode	Rail Modernization	New and Extensions to Existing Systems
Heavy Rail	New York Chicago Philadelphia-NJ San Francisco Washington Boston Cleveland Atlanta Miami	New York Chicago San Francisco Boston Atlanta Washington Baltimore Miami Los Angeles
Light Rail	Philadelphia San Francisco Boston Pittsburgh Cleveland New Orleans	San Francisco Boston Pittsburgh San Diego Buffalo NE New Jersey Portland San Jose Houston Dallas St. Louis Kansas City Long Beach Norfolk Sacramento Los Angeles
Commuter Rail	New York-New Jersey Chicago Philadelphia Boston Caltrans-SF Pittsburgh	
Busways/ Bus Lanes		Houston Charlotte Columbus Honolulu Indianapolis Miami NE New Jersey Nashville New York Orange County Pittsburgh San Antonio San Francisco Seattle Denver

UTICA TRANSIT AUTHORITY

STATEMENT OF THE UTICA TRANSIT AUTHORITY
BEFORE THE SUBCOMMITTEE ON
WATER RESOURCES, TRANSPORTATION & INFRASTRUCTURE

Good morning Mr. Chairman, and members of the subcommittee. I am pleased to have this opportunity to appear before you today.

I am General Manager of the Utica Transit Authority, which operates under a New York State authority, and serves the communities immediately surrounding Utica under special contracts, including the towns of New Hartford, Kirkland, Whitestown, Deerfield and Marcy.

Last year, we carried more that 2.4 million riders at a cost per passenger of $1.27, considerably below the national average, which, we think, speaks well for our system's efficiency.

Our fare is $.60, with adjustments for seniors and students. We increased our fare on July 19, 1985 from $.50, and we have reviewed a possible fare increase. In a region such as ours, with a growing number of senior citizens and disadvantaged, fare increases become difficult and we are seeking new alternatives by developing programs for employees subsidized by employers taking advantage of the Transit Fringe Benefit.

Obviously, no one needs to tell this subcommittee that public transit is an essential public service that has a direct and corresponding bearing on the quality of life and the economic well-being of modern North American communities. That, in providing mobility for nondrivers--shoppers, workers,

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students, handicapped, elderly and the poor--we reaffirm the essential goal of a democracy--to provide equal opportunities for all its citizens.

I am sure you have heard about the implications of public transit on a broad national basis. I want to take a few moments to report specifically on what public transit means to people living in a cluster of small communities in upstate New York, bounded by vast tracts of rural regions and the Adirondack Park system.

As you know, public transportation provides access to central business districts, not only for employees and managers, but also for providers of services, suppliers and shoppers. Developers seek to invest in stable marketplaces and the presence of public transit contributes to stability by establishing and reinforcing development and travel patterns. The relationship between public transit and the health of retail markets is direct and obvious...making retail centers more accessible, which in turn bears directly on the ability to attract customers and increase sales. These apparent truisms, which have national implications, begin in grassroot American communities.

I want to discuss in my few minutes two basic subjects: improving the quality of life for all citizens and economic development. Let me begin with the later first.

Investment in transit provides employment for those who build, maintain and operate the system, as well as for the people who work in businesses, made accessible by transit. Before I speak about the Utica area I would like to quote a short paragraph from the January issue of the Empire State

Report..."There are over 150 transit companies and authorities operating buses in and between communities throughout New York State. The State's economy is dependent upon a strong public transportation system. New York's transit systems provide service to over 1.9 billion passengers a year. Without adequate public transportation facilities, New York City would come to a standstill. Two thirds of all travel into the Manhattan central business districts is by some form of public transportation. In 1986, it cost $4.4 billion a year just to operate and maintain the various public transportation systems in the state. Fifty-five percent of this cost was met by fare box revenues, the remaining funds were provided by local, state and federal assistance. An additional $1.8 billion was expended to make capital improvements to the state's public transit systems."

In upstate New York, as in all regions, jobs were and continue to be, a major concern. With the passage of the Urban Mass Transportation Act providing federal funds for capital improvements, we began in late 1981, through a series of grants, to replace our ancient fleet, which was no longer cost effective.

As the result of this funding authorization, and meeting all requirements for competitive bidding, we were able in 1982, to induce to locate in the Utica region, a Canadian builder of buses, Bus Industries of America, a subsidiary of Ontario Bus, Ltd. and became its first customer.

Today, this company employs 110 and has an annual payroll of $3.6 million. It plans to increase its employment by 60 in 1988 and is spending more than $300,000 in capital improvements and will also spend $1 million to build

another 20,000 square foot plant within the Oneida County Industrial Park site.

This small example has had considerable impact on the region, which historically, has had more than its share of peaks and valleys in employment. While, no one is claiming that this episode was the catalyst for industrial development in the region, those were jobs this region would not have gotten. Today, Bus Industries is building 350 buses annually, and has established a marketing niche' in the United States.

Public transit has played a role in the expansion of the new SUNY campus in Marcy, where it provides special service for students and residents living in an area, previously without bus service.

In another example, public transit was used to transport employees living in Herkimer, Ilion, Frankfort and other rural regions, until such time as private carriers were in a position to provide the service. When a national producer of knitwear sought to expand its capacity by leasing space in Utica, UTA provided immediate transportation for its employees living in the Valley until such time as the private carrier was ready to take on the task. The private carrier could not meet the company's requirements, and the choice was to provide service, or lose jobs. Without public transit, it is safe to conclude that those jobs would have been lost to the region.

Most of us, I think, believe the role for mass transit is to provide adequate service to all citizens, especially those who depend on transit for personal mobility. The cornerstone of this role is not only the provision of funding for both capital needs and operating deficits, but also, technical assistance.

This important, but elusive quality of life for transit providers means mobility for nondrivers.

Giving people access to shopping centers, to hospitals, to businesses, to employment, to schools and colleges, to opportunities, "can be" a way of breaking patterns created by welfare dependency, minimize the problems of aging and providing opportunities for those too young to participate in community experiences that are broadening and far-reaching for society.

Without adequate public transit developers, businesses/industries generally won't locate. Retail sales decline. Tax burden increases, joblessness soars, welfare costs become burdensome, anti-social patterns emerge, the elderly become more disfranchised and communities deteriorate.

In our region, ridership among the elderly, students and the poor increased as we established new incentives and special fares for them to ride. Since 1984, we have witnessed a steady increase in ridership.

In the spring of 1987, we entered into an agreement with the Oneida County Social Services Department, to provide greater mobility for those on public assistance. In the last three months, we saw an 80% increase in ridership. At the same time, the Social Service Department was able to show a budget decline in its transportation for the use of more expense para-transit service, as well as its regular transportation budget. This decrease would be even more significant, providing service was extended. This mobility has also enabled welfare recipients to seek employment outside their own neighborhoods.

In conclusion, we believe any phase out of federal financing, which will eliminate or reduce capital aid and operating assistance, would mean a discontinuation of public transit service, less industrial development opportunities and a reduction in the quality of life for the citizens living in the Greater Utica region.

Obviously, at the present level of funding, we can only meet the minimum requirements for mass transit in the region. We cannot provide the kind of comprehensive mass transit service which is required. We cannot expand service. We cannot establish new routes and meet the area's future needs.

I want to take this opportunity to urge you to provide additional funding for mass transit, so that we can fulfill our obligations to those people who rely on us.

Thank you.

Carmen F. Arcuri

Testimony by Henry Kolm, Ph.D.,
Senior Scientist, emeritus, Mass. Inst. of Technology,

Director, All American Magneplane, Inc.
5183, Seven Springs Blvd., New Port Richey, FL 33552
813 372 8036
and
Chairman, Electromagnetic Launch Research Inc.,
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625 Putnam Ave., Cambridge, MA 02139, 617 661 5655

presented to the Senate of the United States,
Committee on Environment and Public Works,
Subcommittee on Water, Transportation, Infrastructure.

at a hearing on the potential of maglev technology
for crowded transportation corridors.
on Thursday January 21, 1988, at 10:00 am
at the Court of International Trade in New York City

SUMMARY

TRAINS ARE 1830 TECHNOLOGY PUSHED TO ITS LIMIT
obsolete, they no longer satisfy our needs, because
people are no longer clustered in a few large cities
and don't travel city-to-city in straight lines.

MAGNEPLANE IS THE FIRST REALLY NEW CONCEPT, not a train
it is inevitable technology, like the wheel and wing,
perhaps the biggest venture of next century;
if America doesn't lead, we will have to import!

MAGNEPLANE IS GUIDED FLIGHT, not just faster rail
cylindrical vehicle flies inches above aluminum trough
smoothly cushioned, it banks like an airplane,
rides a magnetic wave, which prevents collision
so "cars" can travel non-stop twice a minute
coupled electronically,
using one tenth the wayside power of railroads

MAGNEPLANE's TIME HAS COME
invented in 70, prototype developed with NSF funds,
and added support from several industries,
mothballed in 75, ahead of its time;
a new team of companies is ready to continue,
to solve the World traffic congestion crisis,
and restore U.S leadership in transportation!
Senate Bill 1794 provides this opportunity!

THE MAGNEPLANE TEAM
Henry Kolm, David Ramsey, All American Magneplane,
EML Research Inc., and the KAMAN Corporation.

The Magneplane Concept

Magneplanes fly several inches above an aluminum trough,
containing no motor, only superconducting magnets,
resiliently supported by their own magnetic image,
free to bank like an airplane
and propelled by a travelling magnetic wave
which is generated by wires in the guideway.

The travelling wave is synchronized with the vehicles
by wayside transformers linked to a central computer
which controls the system and ensures separation.

Vehicles start and stop on retractable wheels,
lift off at about 30 miles per hour, and
carry 100 passengers non-stop to their destination.

Vehicles are separated by thirty second headways,
and all stops are made off the main line.

MAGNEPLANE ARTICLES FROM THE 70s ARE APPENDED
Scientific American 1974,
IEEE Trans Mag 1972,
Cryogenics 1975
for those who want to dig deeper.

TRAINS ARE 1830 TECHNOLOGY PUSHED TO ITS LIMIT

Viewed objectively, a train is a very obsolete thing! Consider, next time you climb the stairs into a railway car:

You are climbing onto a huge girder which rides along to concentrate the load on two wheel trucks, just so you can travel on narrow steel rails at an enormous pressure. Thousands of pounds per square inch! To be economical, dozens of such cars have to be hitched together, and pulled by a huge locomotive.

Cross-ties and gravel then distribute this concentrated load over the ground, and huge bridges or tunnels are needed when you can't travel at ground level.

In 1830 it was a clever way to move heavy loads over the prairies, even in mud season! But today it is no longer an appropriate means to transport people over a congested planet! Trains are needlessly expensive and cumbersome. Consider:

Trains carry a thousand people once or twice an hour. This means that everybody has to stop everywhere. About eighteen times between Washington and Boston! Electric trains require a large wayside power supply - typically 60 megawatts - which is used only once or twice an hour, mostly to accelerate the people who didn't want to stop. Between trains, the whole system stands idle.

Trains require very heavy bridges and elevation structures, and tunnels which are about 30 feet square for each track, mostly to accommodate the huge beam under each coach!

Perhaps a railroad's worst problem is its inability to maneuver! A train cannot even follow the grades and curves of an Interstate Highway! We no longer have the space to build new railroad corridors!

Just to negotiate a 40 foot overpass at 200 mph without passengers being lifted off their seats, a railroad requires over two miles of ramp! There often isn't room for two miles of ramp! The Miami-Orlando-Tampa corridor would require over 300 grade crossings!

Railroads were invented just about 200 years ago. In the sixties, new technology was applied to make railroads go as fast as is now possible. The limit isn't much over 100 mph. The time has come for a major re-thinking of the basic problem, not just another round of band-aid modernization!

Remember: we are not building just another generation of airliners, to be obsolete in ten years. We are building the ground transportation system which must take the world through the next century!

Senate Bill 1794 proposes a national effort to do this!

MAGNEPLANE IS THE FIRST REALLY NEW CONCEPT

Magneplane addresses the needs of today, and is therefore an inevitable chapter in the evolution of technology, as inevitable as the wheel and the wing were in their day. Its coming cannot be stopped.

If we don't build magneplanes in America, we will be forced to import something very much like it from elsewhere.

Magneplane is a system of individually travelling cars which resemble the fuselage of a small jet (Boeing 737, DC-9).

Magneplanes travel several inches above an aluminum sheet metal trough, free to bank like an airplane. They are supported by a soft cushion of magnetic field, at about one third the pressure of an automobile tire. They resemble a large bobsled more than a train. The guideway trough is light enough to be supported by inexpensive masts.

By combining a climb with a turn, Magneplanes can negotiate a 40 foot overpass without passengers leaving their seats, using less than a half mile of ramp if need be (a chandelle maneuver).

Magneplanes can travel at a 30 second headway, all vehicles being coupled together electronically. They are loaded and unloaded off-track to make this possible. Thus each magneplane takes its passengers to their destination non-stop or one-stop, like an airliner.

And Magneplane needs only 6 megawatts of wayside power, used twice each minute, instead of 60 megawatts used twice each hour.
Here are the differences between trains and magneplanes:

train	magneplane
heavy train	light fuselage (737)
1,000 psgsrs, twice/hour	100 psgrs, twice/min
10-stop trips	non-stop or 1-stop trips
cars hard-coupled	electronically coupled
large towns only	can serve many small towns
on-line loading	off-line loading
100 mph	200 mph plus
60 megawatts wayside	6 megawatts wayside power
engineer-controlled	central computer controlled
high pressure tracks	low pressure trough
hard rail contact	soft cushion, inertial path
fixed bank	self-banking
limited bank, grade	maneuverable guideway
vibrations, noise	only air noise
active (powered) vehicle	passive (unpowered)
needs a 30 ft sq tunnel	fits in a 14 ft tube
needs many grade crossings	rides overhead on masts

THESE ARE THE ADVANTAGES WHICH MAKE MAGNEPLANE INEVITABLE

MAGNEPLANE IS GUIDED FLIGHT

Magneplanes resemble small airliners without wings, and are passive: they contain no motor, only several large magnets in the form of superconducting current loops or arrays of permanent magnets under the skin of their underside. They have retractable wheels for landing and take-off.

Lift is produced naturally by the motion of the magnets over the conducting aluminum guideway trough. It results from motion-induced currents in the trough which look like an image of the moving magnets. The moving magnets are repelled by their own induced images! Simple, reliable, and inherently stable!

Induced lift can be felt very simply by holding a permanent magnet near the surface of a spinning aluminum disk. For instance, an aluminum disk on a circular saw arbor (the steel saw blade is not a good enough electrical conductor) or to replace the abrasive wheel in a bench grinder. If the spinning disk is horizontal, the permanent magnet will fly an inch above the surface of the disk.

Induced lift is produced at the expense of drag, just as in the case of aerodynamic lift. The force has several remarkable and useful properties:

lift-off occurs at about 20 to 30 miles per hour

lift force is soft, but stiffens as contact is approached

THE FASTER YOU GO, THE LESS ENERGY IS NEEDED FOR LIFT

at 224 mph, aerodynamic drag is twice the magnetic drag

at 224 mph, wayside power required is only 6 megawatts, one tenth the wayside power of a railroad, at six times the passenger handling capacity.

Propulsion is produced by a simple meander winding at the center of the guideway trough. It generates a travelling magnetic wave when energized with three-phase AC current. The magneplane just rides this wave like a surfboard.

The AC current comes from special wayside transformers (cycloconverters) located a mile apart and linked to a central computer. These transformers synchronize the travelling wave with the travelling vehicle on the basis of position information transmitted by the vehicle. They also control the speed of every vehicle, and maintain separation between vehicles.

Wayside transformers also serve as shock absorbers, by damping oscillations of the vehicle. They do this by adjusting the phase and thus the vertical and lateral force of the travelling wave.

More details will be found in the appended articles.

MAGNEPLANE's TIME HAS COME

Magneplane was invented in 1970 by Henry Kolm and Richard Thornton of MIT, which owns the three basic patents. It was developed to the point of an operational prototype scale system with support from MIT, the National Science Foundation, and an industrial consortium including Raytheon, Avco, Alcoa, and 3-M. Tests on a 400 foot guideway were highly successful and widely publicised in 1974. They were shown in several NOVA features.

In February 1975 the Office of Management and Budget terminated funding for all high speed ground transportation research in the US. Magneplane was mothballled, with film footage and much technical information unpublished. German, Japanese and Canadian projects adopted some of the basic magneplane concepts (notably the linear synchronous motor approach, but not the self-banking guideway nor the overall system control).

In 1981 Henry Kolm took his applied research group out of the MIT National Magnet Laboratory, and set it up as Electromagnetic Launch Research Inc. The company is now building the first electromagnetic aircraft catapult for the Navy, and the first electromagnetic anti-tank gun for the Army.

In 1985 EML Research Inc. became part of the Kaman Corporation, a 5,000 employee aerospace team best known for its leading edge technology in general. It is headed by Charlie Kaman, a noted innovator and one of the inventors of the modern helicopter. Kaman makes helicopters for the Navy and advanced components for other major aerospace firms.

In 1982 Henry Kolm joined with David Ramsey in founding All American Magneplane, Inc., for the purpose of developing a magneplane system for the Florida corridor. Research was to be done by EML/KAMAN, with funding from a Florida land development consortium.

All American Magneplane proposed what appears to be the only workable system, but private funding has failed to materialize. The entire Florida corridor venture is in jeopardy.

Development of a magneplane system is vital to the economy of the United States, not just Florida. It represents a much-needed opportunity to solve our transportation crisis and regain technolgical leadership in an industry on which we have depended heavily for almost a century.

Without a national effort, we will lose this opportunity. Senator Moynihan's Senate Bill 1794 proposes such an effort. It deserves your enthusiastic support!

THE MAGNEPLANE TEAM

Henry Kolm is one of the founders of the MIT Francis Bitter National Magnet Laboratory, an authority on electromagnetic technology with over 25 years of experience, and a recognized inventor, innovator and industrialist. He was named Entrepreneur of the Year 1981 by Money Magazine, and was awarded the Peter Mark Medal by the Department of Defense for outstanding contributions to electromagnetic launch technology.

Kolm is Chairman of Electromagnetic Launch Research Inc., a KAMAN Company, Vice President of Piezo Electric Products Inc., largest US manufacturer of piezoceramics, and a director of All American Magneplane Inc. He is also a faculty member emeritus of M.I.T.

After earning his Ph.D. in Physics from MIT in 1953, Kolm developed world record electromagnets, designed the MIT National Magnet Laboratory, and initiated a number of applications including the earliest superconducting magnets, supercritical helium cooling systems, pulsed field metal forming, high gradient magnetic separation and filtration, the magneplane system, and electromagnetic launchers. Kolm has published about 60 professional papers, and holds over 30 US and foreign patents.

David Ramsey is President of All American Magneplane, Inc., President of his own civil engineering firm for fourteen years, and a registered professional engineer in seven states, with twenty-four years of professional experience.

All American Magneplane Inc. is a Florida Corporation founded in 1984 for the purpose of financing the development of a practical magneplane system for Florida, and the World.

Electromagnetic Launch Research Inc., a member of the Kaman Diversified Technologies group, is a world class research team involved in leading edge power technology. It is backed by one of the most advanced manufacturing organizations in the World today.

MAGNEPLANE ARTICLES FROM THE SEVENTIES ARE APPENDED:

Electromagnetic Flight
Scientific American, October 1973
The Magneplane: Guided Electromagnetic Flight
Proceedings of the 1972 Applied Superconductivity Conference
(the first magneplane publication)
The Magneplane System
Cryogenics, July 1975
(the last magneplane publication)

KOLM, HENRY HERBERT, b Vienna, Austria, Sept 10, 24; nat US; m 53; c 4. MAGNETISM. *Educ:* Mass Inst Technol, SB, 50, PhD(physics), 54. *Prof Exp:* Asst low temperature physics, 50-54, mem res staff, Lincoln Lab, 54-60, SR SCIENTIST & LECTR DEPT AERONAUT & ASTRONAUT, MASS INST TECHNOL NAT MAGNET LAB, 60- *Mem:* Am Phys Soc; Am Inst Aeronaut & Astronaut; Inst Elec & Electronic Engrs. *Res:* Hydrodynamics of liquid helium; semiconductor surface physics; cyclotron resonance in solids; design of pulsed and continous high-field solenoid magnets; superconductivity; magnetic separation; magnetic levitation and propulsion of high speed vehicles; applications of magnetism; piezoelectricity. *Mailing Add:* Weir Meadow Wayland MA 01778

Mag-Lev Transport for the 21st Century

Testimony of Professor Francis C. Moon
Director of the School of Mechanical and Aerospace Engineering, Cornell University
Before the Senate Committee on Environment and Public Works
Subcommittee on Water Resources, Transportation and Infrastructure
Hearing on Magnetic Levitation for High Speed Ground Transportation
Thursday, January 21, 1988

The astronomer Fred Hoyle once wrote a science fiction story about life in the future in which he describes their transportation system; "They simply ride on a magnetic field. The logistics of it work just like a railway system.... But the tracks are magnetic, nothing at all like railway lines. The great thing about it is that it's all silent, and computer controlled."[1]

Today, that science is no longer fiction; and the future may not be found in the United States, but in Japan or Germany. The proposed Senate bill S.1794 by Senator Moynihan represents a first step toward bringing the United States back into transportation leadership for the next century.

This Bill recognizes that we are on the verge of a new revolution in transportation which requires bold moves by this nation if we are to remain economically competitive in this area of technology. This Bill also comes at a time of great scientific excitement about new discoveries in superconductivity. But, however remarkable the new discoveries are, the advances in conventional superconductivity in the last decade has already made its impact on new technologies, such as magnetic levitation for high speed ground transportation.

The overcrowded skies at major United States airports demonstrate the need for a new addition to our transportation options. Since a significant percentage of air traffic is between cities at distances less than 500 miles, superconducting mag-lev transport at 300 mph is the ideal solution to provide additional capacity to our city to city transportation system.

Proposals for the use of superconductivity to levitate and propel trains were made in this country in the 1960's. One proposal by two scientists at Brookhaven National Laboratory, Dr. Jim Powell and Gordon Danby, appeared as a lead article in the magazine Mechanical Engineer in 1967. Small models of mag-lev vehicles were actually built and tested at MIT by Dr. Henry Kolm and R. Thornton, as well as at Ford Research Laboratory, and at Princeton and Cornell Universities in the early 1970's. Each of these U.S. based research efforts died for lack of funds while our Japanese and German colleagues moved these research ideas from the laboratory to engineering and testing full scale prototypes at speeds up to 300 mph. In fact, just last week I mothballed my mag-lev dynamics laboratory for lack of support.

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[1]From "October The First Is Too Late", 1965.

In 1978 and 1982 I was invited along with a few other U.S. engineers and scientists to witness the testing of Japanese superconducting mag-lev test vehicles. It was clear even in 1982 when they tested a three-car set, that Japan was 5-10 years ahead of the U.S. This year Dr. Kyotani, formerly the head of Japan's Mag-Lev Project, visited me at Cornell and told me that their mag-lev transport technology was ready to be marketed worldwide without the need for the new superconducting materials. The West Germans also have been active in trying to market their version of mag-lev transportation abroad including several U.S. cities and states.

This new transportation technology has been so neglected in this country that cities and states do not have the technical manpower, expertise nor experience to provide critical assessments of these new technologies. There is the danger that through lack of knowledge about superconductivity and magnetic levitation that some states may invest in nineteenth century transportation at a time when we should consider solutions for the 21st century. In the case of the proposed Las Vegas-L.A. mag-lev project, a Canadian group was asked to evaluate different proposals from Japan and Germany. Not only have we lost a technology and the ability to add new markets for the United States transportation manufacturing industry, but we have lost the technical expertise to even judge the feasibility of these new technologies. Clearly, there is a federal role in bringing the U.S. back into mag-lev leadership.

In the early nineteenth century the United States embraced the new technology of the steam railroad instead of optimizing the stage coach system. Likewise, in the late 1940's, the United States advanced the technology of jet powered civilian aircraft instead of improving the propeller driven Super Constellation, and overtook the British lead in developing jet engines. With this bill we have the opportunity to regain the lead in mag-lev transportation in the 1990's.

Before we can assess the potential of superconducting mag-lev transport, we need to develop a cadre of engineers and scientists who understand and have had experience with this new technology. This brings forth another point regarding mag-lev development; that is, the balance between engineering and science. We must, of course, continue to fund research into the science of superconductivity, especially with respect to the new materials. However, bringing new scientific ideas to economic reality requires engineering, including engineering research and education. I know of no course of study in any U.S. engineering college that teaches design of superconducting magnets. While magnet engineering expertise exists in small pockets in several government labs, there is a lack of manpower and experience in many major American engineering corporations. Thus it is important to involve American industry and engineering schools in a major way in the new technology of mag-lev transport in order to build engineering teams with knowledge and experience which will eventually be tapped to build a national mag-lev system.

Besides the design of superconducting magnets, successful development of high-speed mag-lev transport requires vehicle and guideway design, aerodynamics, guideway electric power design as well as the study of control strategies of vehicle dynamics. This suggests a development path similar to a new aircraft, and the choice of NASA as a management agency is logical. However, DOE has had more experience with superconducting technology and could also lead this effort. What is clear, however, is that it is premature to ask DOT to do an immediate feasibility study on mag-lev transportation without first regaining our technical expertise in mag-lev superconducting technology.

I would propose a schedule that would start with building a technical group of engineers and scientists for industry, universities and government labs such as DOE and NASA to study the best mag-lev configuration for high-speed transportation. This effort might take one-two years. I would then recommend building a full scale prototype mag-lev vehicle beginning in 1990 to test critical technical issues and to gain experience. Based on this experience, I would then ask DOT to conduct a feasibility study for a demonstration project after we have built up a technical and engineering knowledge base.

With respect to the time scale of this Bill, I would suggest that if we are serious about a revolutionary national mag-lev transportation system, we must be prepared for a long period of development running to the end of this century. In the last three decades we have been conditioned by the insta-technological successes of micro-science starting with the transistor and including the new chips that power our supercomputers. However, building new power sources, infrastructure, space stations, and a new transportation system are macro-technologies and these operate on different time scales. The time between the first Comet Jet to the 747 Jumbo Jet was around 15 years. This is the proper time scale not only for mag-lev transport development, but for other macro-technological applications of new superconducting materials.

In summary, I am supportive of the general goals of this Bill to advance mag-lev transport technology. I would encourage the development of a prototype system using conventional superconducting materials to allow American companies and engineers to gain experience in the next five years. During this period one would hope that new scientific and engineering breakthroughs in the new superconducting materials might allow us to leap-frog the current Japanese and German mag-lev technologies.

I would close with two quotes from Americans with vision for the future of transportation:

> "We may perhaps learn to deprive large masses of their gravity and give them absolute levity, for the sake of easy transport"
>
> Benjamin Franklin

Finally, from the November 1909 issue of Scientific American, an article by the "Father of American Rocketry", Robert Goddard, writing about a tunnel from New York to Boston:

> "The cars might be held in suspension by the repulsion of opposing magnets.... When thus isolated, they could be propelled by the magic power of magnetism".

I hope we can realize this dream by 2009.

MOON, FRANCIS C. b Brooklyn, NY, May 1, 39; m 62; c 3. SOLID MECHANICS. *Educ:* Pratt Inst, BSME, 62; Cornell Univ, MS, 64, PhD(theoret & appl mech), 67. *Prof Exp:* Asst prof mech & aerospace eng, Univ Del, 66-67; asst prof aerospace & mech sci, Princeton Univ, 67-74; assoc prof, 75-81, PROF & CHMN, DEPT THEORET & APPL MECH, CORNELL UNIV, 81- *Concurrent Pos:* Consult, Rand Corp, Calif, 67-69, Boeing Vertol, 71-72, Int Tel & Tel Corp, 78, SCM Corp, 79-80 & Argonne Nat Lab, 80- *Mem:* AAAS; Am Soc Mech Engrs; Am Acad Mech. *Res:* Wave propagation in solids; composite materials; magneto-elasticity; magnetic levitation of trains; superconducting magnets. *Mailing Add:* Dept of Theoret & Appl Mech Thurston Hall Cornell Univ Ithaca NY 14850

COALITION FOR IMPROVED TRANSPORTATION AND AIR QUALITY

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STATEMENT OF THE COALITION FOR IMPROVED TRANSPORTATION AND AIR QUALITY TO THE U.S. SENATE SUBCOMMITTEE ON WATER RESOURCES, TRANSPORTATION, AND INFRASTRUCTURE OF THE COMMITTEE ON ENVIRONMENT AND PUBLIC WORKS AT ONE FEDERAL PLAZA IN NEW YORK CITY

JANUARY 21, 1988

Chairman Moynihan, members of the subcommittee, ladies and gentlemen: My name is Scott Steffey. I am the Executive Director of the Coalition for Improved Transportation and Air Quality, a coalition of many of the leading businesses and business organizations in the New York metropolitan region, as well as civic and community groups, labor unions, health services providers, the tourism and entertainment industries, the retail and real estate industries, hotel and food industries and other members of the public. Over 4,000 businesses and a half-million workers in New York City are members of the Coalition.

The impetus for the formation of the Coalition is the New York City Department of Transportation's proposal to restrict or prohibit motor vehicle access to Manhattan's Central Business District.

Over the past year, we have conclusively demonstrated that these restrictions would devastate the region's economy, leave tens of thousands of commuters without adequate access to Manhattan and make transportation conditions outside of Manhattan unbearable.

However, this Coalition has taken positive steps in addition to our criticism of draconian vehicle restrictions. In our White Paper--which is available upon request--we outlined numerous options for improving transportation conditions in the metropolitan region. I would like to briefly discuss a few of those options with you today.

One important premise that we continue to emphasize is that mass transit can successfully compete with the automobile as the transportation mode of choice. According to the New York City Transportation Commissioner 90% of the people who work in Manhattan's Central Business District use mass transit to get to their jobs. Nonetheless, vast improvements must be made to our mass transit infrastructure if New York is to continue the current trend of decreased auto use and increased transit ridership.

The MTA's capital improvement program needs continued support. The fact that there are 90,000 more subway riders now then there were just a few years ago is testimony to the benefits of this program. However, the increased ridership also adds additional pressure to expand capacity. A number of lines are currently running at full capacity during rush hours. Headway times must be decreased and unfinished projects like the 63rd Street Tunnel must be completed and made functional.

Additionally, we must make our subways easier, more comfortable and less costly to ride. Strategies ranging from off-peak pricing, free or low-cost bus-to-subway transfers and low-cost weekly, monthly or annual subway passes should all be seriously considered as means of capturing more riders. Also we must change the perception (real or imagined) that New York's subway system is unsafe and unsanitary. It will take a monumental effort by the MTA and others to change this perception but it is absolutely essential. We understand that the MTA is contemplating a massive public education campaign to "market" mass transit, an effort which should receive the widest possible support.

A special effort should be made to make commuter rail more attractive and more accessible. Tens of thousands of suburbanites who drive into midtown Manhattan each workday would <u>rather</u> take the train but can't because there are insufficient

parking spaces at the suburban railroad stations, particularly along the Metro North line in Westchester County and the northern suburbs, on the LIRR and in many Connecticut townships. A crash program must be implemented immediately to expand commuter parking facilities. This is especially important if the rail system is to handle new riders resulting from residential growth. Also, electrical rail service needs to be extended throughout Long Island and special "First Class" cars should be experimented with in an attempt lure executive commuters.

One way to make mass transit more competitive with the private car is to increase transit subsidies to $60 per employee per month. Currently an employer can offer to subsidize an employee's car commute. However, a similar package can not be offered for mass transit. Raising the mass transit subsidy to $60 would be a step in the right direction.

New York City must make greater use of its waterways. Not only should ferry service for passengers coming to Manhattan be increased, but ferry service for buses and trucks must be considered. Currently, 40% of the trucks that pass through the Lincoln and Holland tunnels do not have a destination in Manhattan. Ferry service for these vehicle from New Jersey to the outer boroughs might be a creative way to reduce truck congestion in Manhattan. Similarly, the Port Authority has proposed to relieve congestion in New Jersey by turning abandoned

freight tracks into "busways" and then transporting the buses to Manhattan by ferry. This plan deserves greater support than it currently enjoys.

Finally, New York City must begin to plan capital projects for the future. The likely decay of the East River bridges and residential growth in the northern suburbs and eastern Long Island will require new mass transit options that service the entire region. We are very excited about innovative transportation breakthroughs like the electromagnetic levitation transport system. This system may hold the solution to many of our problems. However, without these options, the region will not be able to sustain economic growth.

Thank you.

3.5/usswrti

Testimony of Dr. James R. Powell* and Dr. Gordon Danby** on "The Potential of Magnetic Levitated Transport in the United States"

BACKGROUND

In 1966, we published the first work, ASME-66 WA/RR-5 "High Speed Transport by Magnetically Suspended Trains." This sparked great interest, both in these United States and abroad, and inspired many groups to start programs.

We have continued to work on magnetic levitation. Our published inventions include, besides the original concept for a superconducting magnetically levitated train, the null flux suspension and the linear synchronous motor (LSM). These concepts are used in the superconducting magnetically levitated train system demonstrated by the Japanese National Railway (JNR). We obtained the pioneering U.S. patent on superconducting magnetically levitated trains (Patent Number 3,284.744).

Over the years, we have freely provided details about our work to various magnetic levitation efforts including programs in the U.S. and Japan, Federal Republic of Germany, and Canada. Following our first paper in 1966, there was initially a strong program in the U.S., with participation by Stanford Research Institute, Ford, Massachusetts Institute of Technology and others. However, the U.S. program withered away after a few years, due to lack of government direction and support.

The strongest and most sustained program has been the Japanese. During the first several years of their effort, we were frequently visited by high level representatives from JNR and Japanese industry and universities. In our discussions of magnetic levitation and propulsion designs, we were impressed by their commitment and engineering excellence. As their program matured, contacts inevitably became less frequent. However, we have maintained contact with Dr. Kyotani, the Research Director (now retired) of JNR, who was responsible for the Japanese program and who has always graciously credited our contributions to magnetic levitation.

*Head, Reactor Systems Division, Brookhaven National Laboratory, Upton, NY
**Senior Physicist, Brookhaven National Laboratory, Upton, NY 11973

NEEDS AND GOALS FOR MAGNETICALLY LEVITATED TRANSPORT

The present U.S. transport system, which is principally based on cars and airplanes, is losing capability to rapidly, efficiently, and safely move people. The system is nearing saturation -- delays of hours are common on airplanes (the "scheduled delay") and expressways are jammed, making commuting in effect a second job.

These problems will get worse, not better. Automobile traffic continuously increases, but there is no room for new highways; more airplane flights vie for a fixed number of takeoff and landing slots.

Magnetically levitated transport can dramatically improve U.S. transport capability. A single line of track, for example, could easily carry one hundred thousand people per day, at speeds of 300 miles per hour, with an energy cost far below that of automobiles and airplanes. Delays should be rare, and the system unaffected by weather. Environmental impact will be minimal -- there is no pollution (the trains are electrically propelled), noise is practically eliminated (no wheel on rail contact) and land use is less than highways or railroads.

Besides passengers, magnetically levitated trains can efficiently and at low cost carry freight, autos, and other goods. Manufacturing centers can be directly connected, reducing transport time and cost. The energy cost per passenger-mile will be considerably less than with present transport systems, and will not require oil-based fuels.

The major goals for magnetically levitated transport should be:

1. Safety
2. Affordability
3. Flexible right of way siting
4. Capability for multi-purpose use

Safety is a paramount goal. Our work has aimed at magnetic levitation designs that are highly reliable and incapable of failure. Redundant and backup train magnets and cryogenic system make it impossible for any component malfunction to cause failure of levitation. The null flux suspension is extremely stable -- an external force much larger than the weight of the train would be required to make it contact the track.

The suspension overcomes any external force in any direction, whether lateral, vertical, roll, pitch, or yaw, and maintains stability and clearance under all conditions.

Using the Linear Synchronous Motor (LSM), trains can be electrically propelled at high efficiency along the track at precisely separated and controlled intervals. The control is inherent; separation between trains is constant even if trains are subjected to different local conditions (e.g. wind forces, grades, etc.) and automatic (i.e. no human or computer control is required). This capability results from the "phase-locking" characteristic of the LSM. Such inherent automatic control allows safe operation at high speed and high traffic density.

The superconducting suspensions have a large clearance between the train and track, on the order of 6 inches (it can be designed larger if desired). An inherently stable large clearance is very important, we believe, for maintaining safety and keeping track cost reasonable. For these reasons, we feel that the unstable attractive force suspension approach, in which servo-controlled magnets must maintain a clearance of only 1/2 inch, is less desirable than the superconducting magnetic suspension.

Finally, we believe that it is prudent that passenger exposure to stray magnetic fields from the train suspension magnets be minimized. Our goal has been to keep passenger exposure at normal Earth background field values (≈1 gauss) through appropriate design of the train magnet system and use of local shielding.

Affordability is the second paramount goal. The principal cost component in any magnetically levitated transport system will be the track. Although there has been much excitement about high temperature superconductors and their impact on the feasibility of magnetically levitated transport, it is track cost that is the principal barrier, not the cost of the superconducting train magnets. Present superconducting magnets are cost effective for magnetically levitation, even at liquid helium temperatures.

Our recent work has convinced us that large reductions in track cost are possible, without compromising safety, stability, and performance. Using improved design approaches, components can be mass produced and assembled with a minimum of field construction and cost. A two-way track cost of approximately 2 million dollars per mile (exclusive of right of way) is a very attractive goal, and would allow widespread use. Such a track cost appears possible with a proper design approach.

Flexibility in Siting - One must avoid "highways in the sky," that is, the equivalent of building a second deck above the Long Island Expressway. Not only will such track systems be very expensive, but they require massive land-use, severely limiting siting locations.

A magnetically levitated transport system should be siting-flexible, capable of using existing rights of way (either auto or railroad) and co-existing with them. It should be compatible with tunneling, cut and fill, surface type and (where required) elevated (pylon) type construction. Appropriate barriers (e.g. fencing) may be needed to limit access.

Capability for Multi-Purpose Use - A U.S. high speed magnetically levitated transport system should be capable of evolving to meet multi-purpose applications, such as the rapid movement of heavy freight at high energy efficiency. This could also include auto-train systems that could help offset the lack of public transport infrastructure for the many U.S. locations where point to point transport is not sufficient.

TECHNOLOGY DIRECTIONS

1. The JNR using a well planned and broad based application of our original concepts have demonstrated multi-vehicle trains that successfully carry people at high speeds. The technical components are at hand to build first generation commercial systems.

2. A U.S. program should leap-frog the JNR technology, going beyond it to track and vehicular designs that will be cheaper and can, when desired, carry heavy freight in an expanding and evolving system. Our recent studies indicate that this is practical while preserving the features of full magnetic shielding, large clearance and low energy consumption.

3. There are two other approaches proposed for magnetic levitation.
a) Germany is pursuing small clearance (1/2 inch) attractive force magnetic levitation. This is inherently unstable (the train magnets are strongly attracted to the rails above them) and must be controlled by rapid servo adjustment of the magnet current.

It is our belief that this approach is not practical for high speed (200 to 300 mph) transport. This attractive force suspension could theoretically be a quiet "subway," providing an alternative to rubber tired wheel on rail cars that would operate at relatively low speeds.

b) Various authors have studied the so-called conducting sheet repulsive force suspension. In this concept, relatively large superconducting train magnets inductively interact with an continuous conducting aluminum sheet that extends below the train, generating a-magnetic suspension force. This approach has a number of drawbacks.

(1) The suspension is weak, not strongly inherently stable.

(2) It has high magnetic drag and high energy consumption. (Lift to drag ratio is lower than that of airplanes).

(3) Track costs will be high, due to the large amount of materials and field construction required.

(4) It is harder to magnetically shield the passenger compartment.

The Japanese and ourselves chose not to follow this approach, and have concentrated on the more promising inductive loop type suspensions.

4. The new high temperature superconductors have correctly generated great enthusiasm, in part out of technical interest and in part out of belated concern for technical competitiveness. They indeed have very attractive possibilities for levitation.

It must be emphasized however that, compared to various other applications of superconductivity, the levitated train system can function economically and reliably with present day superconductors. The use of the new superconductors is desirable, but not necessary, for developing a working system.

GOVERNMENT POLICY AND INITIATIVES

We believe that a U.S. program on magnetically levitated transport should have the following features:

1. Industry oriented
2. Near term application ("fast track" program)
3. Emphasis on technical and economic practicality
4. Competitive "horse race" approach in initial stage
5. "Leap frog" Japanese and FRG technology
6. Government research on long range, advanced technology

Industry Oriented, because the necessary technical expertise already resides in U.S. industry. If properly directed, it can quickly develop practical, economic systems.

Near Term Application, because it efficiently uses resources, focuses on real needs, and forces us to catch up with foreign systems.

Emphasis on Technical and Economic Practicality, because there is no point in developing technology that cannot be used. The U.S. goal should be to minimize cost and maximize technical simplicity, so that magnetically levitated transport can grow to be widely used, rather than be an expensive "white elephant" kept alive only by government subsidy.

Competitive "Horse Race" Approach, because it allows the best approach, both technically and economically, to quickly emerge. Using an open competition solicitation, design study contracts could be awarded to promising proposals by various industrial teams. These initial studies would take on the order of one year. The designs would then be evaluated, taking into account how well they were analytically and experimentally validated as well as their technical and economic attractiveness. There then would be a down-select of designs and teams, with the surving approaches carried into more detailed development and testing.

In such a "horse race," it is important to have highly qualified, technically aggressive government administrators and contract monitors who will actively challenge industry to come up with innovative, faster, and cheaper designs.

"Leap Frog" Japanese and West German Technology, because it is pointless to duplicate their systems. The U.S. should develop better approaches, particularly with regard to track cost. Actually, right now it is to our advantage to be starting from behind, since foreign systems are to a great extent "locked in" to their technologies and cannot readily change. As emphasized above, however, the U.S. should not pursue dead-end approaches that do not provide a clear improvement. Realistic assessments need to be made; if proposed designs are not clearly better than the already proven Japanese and German systems, they must be dropped.

Government Research on Long Range Technology, because long term, high risk/high payoff efforts fit best in government laboratories. This could include work on high temperature, high current superconductors and ultra low drag trains, for example. The optimum support level for this fraction of a U.S. magnetic levitation program is probably about 10 to 15% of total funding.

IMPORTANCE OF THE U.S. MAGNETIC LEVITATION PROGRAM

It is very important to begin a U.S. program on magnetically levitated transport as soon as possible in order to remain competitive. If a strong program is not in place within the next few years, the U.S. will lose its chance of overtaking foreign efforts. Their system will evolve, becoming simpler and cheaper, closing the door to opportunity. The U.S. will inevitably have to buy systems rather than develop our own.

If we start now, we can develop better approaches that can be used in our country to improve our transportation system and provide a better quality of life.